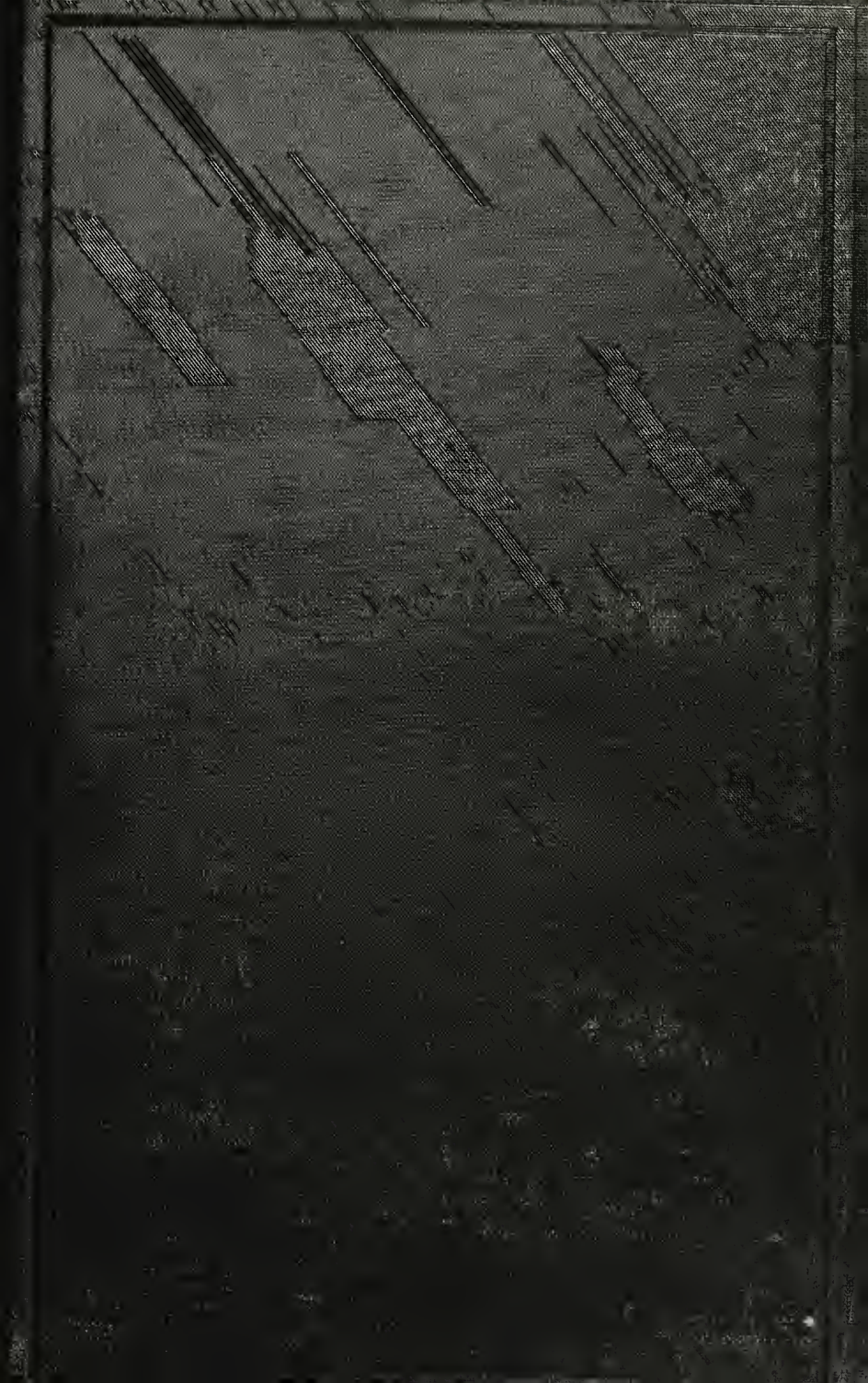
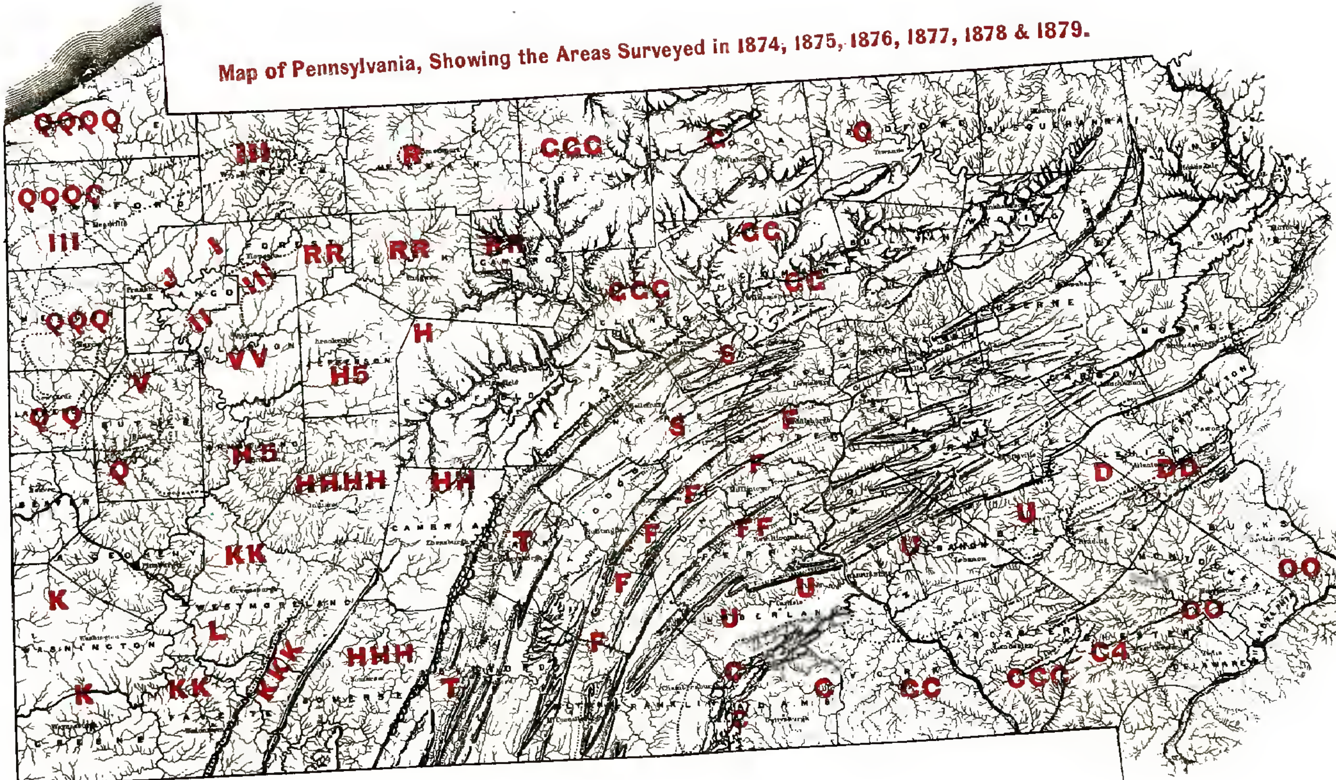


Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878 & 1879.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
REPORT OF PROGRESS, G⁴.

PART I.

THE GEOLOGY OF

CLINTON COUNTY.

PART II.

A SPECIAL STUDY OF THE

CARBONIFEROUS AND DEVONIAN STRATA

ALONG THE WEST BRANCH OF THE

SUSQUEHANNA RIVER.

BY

H. MARTYN CHANCE.

A COLORED GEOLOGICAL MAP OF CLINTON COUNTY,
A SHEET OF LONG SECTIONS ARRANGED FOR COMPARISON,
A LOCAL TOPOGRAPHICAL MAP OF THE RENOVO COAL BASIN,
SIX PAGE PLATES, 21 FIGURED SECTIONS IN THE TEXT, AND
AN INDEX TO THE NAMES OF PERSONS AND PLACES.

Included in this report are

A DISCRIPTION OF THE RENOVO COAL BASIN,
By Chas. A. Ashburner.
NOTES ON the Tangascootack coal basin in Centre and Clinton counties,
By Franklin Platt.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1880.

Entered, for the Commonwealth of Pennsylvania, in the year 1880, according to acts of Congress,

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PHILADELPHIA, *November 19, 1880.*

To His Excellency HENRY M. HOYT, *ex-officio Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania*:

SIR: I have the honor to transmit to you the Report of Progress of the Geological Survey made by Mr. H. Martyn Chance in Clinton county, with a carefully colored map of the county on the best geographical basis at our command.

This map of course possesses no more scientific value, as far as regards the true delineation of its land lines, roads, and water courses, than the maps of other counties in the State. In fact, the wild and mountainous nature of two thirds of its area, and the slight inducements presented to owners of large tracts on which no useful minerals are known to exist, to have them accurately surveyed, in the absence of any regular topographical survey of Pennsylvania at large, makes the geographical basis of this map of even less value than usual, although it will compare favorably with the maps of the adjoining counties of Centre, Potter and Lycoming, suffering under similar disabilities.

But as a geological map it has a high value, both practical and scientific, for it shows, within very moderate limits of error, the areas of the formations, the patches of coal land surface, the outcrop belt of the fossil iron ore, and the outspread of the Nittany valley limestone. But it does not show the localities of brown hematite ore banks in that valley. For this purpose a special map must be prepared, in the further progress of the Survey, in connection with the more numerous ore deposits of Centre county, the detailed survey of which has not yet been undertaken.

The second part of this report is devoted to a special survey of the walls of the great cañon of the West Branch

above Lock Haven, for the purpose of obtaining a series of comparative sections (supplemented downwards, in some cases, by the records of oil well trial borings) which would be likely to settle some open questions in our geology; especially the rate of thinning of our Catskill, Pocono and Mauch Chunk formations northwestward and westward; and the relations of their outcropping strata at the front of the Allegheny mountain, where we know them best, with their correlative strata bored through in the Oil regions and exposed at the surface again in Western New York and Northern Ohio.

The results have been in the main satisfactory; and a general harmony of the formations of Middle and of Western Pennsylvania has been obtained; not entirely divested of doubtful features indeed, but narrowing very much the limits of outstanding error; proving the rapid thinning of the great Catskill and Mauch Chunk red formations of Middle Pennsylvania westward as we approach the Oil Regions, and rendering it almost certain that other red strata come in locally at other horizons, by which the various "reds" of the Oil Well records are explained.

Geologists must be referred for a more precise explanation of the situation to the text and illustrations of the report; especially to the large sheet of serial sections upon which most of the data are portrayed.

It was my intention to have for publication with this report a contoured map of the Susquehanna West Branch valley from St. Mary's down to Lock Haven; but it was impossible to detail any part of the corps for so serious an undertaking; nor would the appropriation permit the employment of an extra field party for that purpose. Therefore it had to be postponed. The contoured map of the Renovo mountain, however, furnishes a good specimen of what such a map would be along its whole line; especially wherever the mountain wall is capped by the Conglomerate measures. Such a map should run far enough up the side valleys, vales and ravines to show their different character, and should extend back along the central lines of the syn-

clinals which hold any coal measures. This is certainly a proper part of the future work of the Survey.

Particular attention has been bestowed upon the fire clays of the district.

Yours respectfully,

J. P. LESLEY.

PHILADELPHIA, *August 18, 1880.*

Prof. J. P. LESLEY, *State Geologist:*

DEAR SIR: I herewith present for your approval my report on the detailed geology of Clinton county, to which is appended a survey of the subcarboniferous rocks from Lock Haven westward to the Butler, Clarion and Venango oil-belts.

Nearly all the material for these reports was obtained in 1878, but it was not possible to systematize this until my survey of Clarion county (since published) was completed in 1879.

My thanks are due to many resident gentlemen of the district for courtesies tendered the Survey; among others I would especially mention Messrs. Merriman and Munson of Williamsport, Col. Noyes of Westport, Mr. Nicholas Mann of Reâvilleton, and Mr. Jas. Davids of Lock Haven.

I remain, dear sir,

Very respectfully,

Your obedient servant,

H. MARTYN CHANCE.

TABLE OF CONTENTS.

PART I.

Geology of Clinton county.

PART II.

Special Survey of the Sub-carboniferous Rocks along the Susquehanna River.

LIST OF ILLUSTRATIONS.

Cuts in Text.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS.

ON THE

GEOLOGY

OF

CLINTON COUNTY.

Chapter I.

Location, Area, Topography, Terraces, Drainage, Soil, Ores.

§ 1. Clinton county is located in the northern central portion of the State, lying south from Potter, and southwest of Lycoming county, with Cameron and Clearfield on its western side, and Centre along its southern border. It formerly extended much farther northwest; but the act creating Cameron county truncated that corner, cutting off nearly all of Grove township and the area northwest of Grove.

The triangular piece of that township still left to Clinton, has been united to Keating township; but as the latter has been sub-divided into East and West Keating, it now forms part of East Keating.

All the old county maps show Chapman township as a large L shaped tract of about 150 square miles, but it is no

longer so large, having been split into two, which are known by the names Chapman and Noyes.

§ 2. *Area.*—The area of the county, according to the county maps,—from which the accompanying map has been prepared,—is betwen 850 and 880 square miles, but other sources of information make it probable that this is much too small, and that the true area is about 900 square miles, possibly even slightly in excess of that figure.

Owing to the comparative poverty of the soil on the Allegheny plateau, the population north of the Allegheny mountains is quite sparse; but the valleys south of the mountains are quite fertile and support a much larger number per square mile.

Topography.

§ 3. In the southern part of the county the outcrops of the Medina and Oneida sandstones produce several sharp rugged roughly parallel mountain ridges, between which three fertile limestone valleys nestle. These are all anticlinal valleys, having a floor of Lower Silurian limestone, which has been brought up to daylight only upon the arches of the anticlinals.

Sugar valley, the most southerly of these, lies just north from Centre county. It is surrounded everywhere by the mountainous outcrop of No. IV. Big Fishing creek heads in this valley and has its outlet into the Nittany valley through a sharp gap in Nittany mountain.

Nittany mountain is a double or synclinal mountain, lying between Sugar and Nittany valleys. The minor red shale valley of No. V, (Clinton red shale,) known as the valley of Cherry run, is situated between the two crests of this mountain.

The Nittany mountain synclinal trough flattens out to the east; and its complementary anticlinal—that of Nittany valley—also becomes more gentle, arching over into the Bald Eagle or Muncy mountain, and cutting off the topographical connection between Nittany and Nippenose valleys. The latter is, geologically, a mere continuation of the former beyond this mountainous arch.

Bald Eagle mountain crosses the county from west to east in a nearly straight line, bearing about N. 65° E. It is formed by the northwest dipping sandstones of No. IV, which here are seen for the last time in Pennsylvania, not re-appearing until brought up to daylight in New York and Ohio. The dip is usually quite steep, nearly always exceeding 40 degrees.

Bald Eagle valley lies north of Bald Eagle mountain, and stretches northward to the foot-hills of the Allegheny mountains, a distance of about two and a half or three miles, including the outcrops of the Lower Helderberg limestones, (No. VI,) the Oriskany sandstone and lime shales, (No. VII,) and the Upper Helderberg, Marcellus and Hamilton groups; gradually rising over higher and higher hills until the basset edges of the Catskill or Old Red sandstone (No. IX) is reached.

The lower part of the valley is remarkable for its flatness. From Mill Hall gap eastward to Pine creek this feature is especially noticeable. The flats in some places are over a mile broad, being much broader at Pine creek than at Lock Haven or Mill Hall gap. They have probably resulted from the rapid erosion of the easily disintegrated limestones and shales of No. VI, which here present a very broad outcrop or several successive of outcrops due to the existence of several minor folds traversing them from west to east.

The escarpment of the Allegheny mountains presents a rather irregular face, running in a general direction approximately parallel to Bald Eagle mountain. It is gaped, within the county limits, by the valley of Beech creek on the west, and of Pine creek on the east, with the great valley of the Susquehanna near its center. Though its southern slopes are quite steep, and usually quite rugged, the coal industry of the Tangascootock and Queen's run has led to the building of several roads directly over it from Bald Eagle valley, and though most of these have fallen into disuse, several of them are still passable.

There is but little land on the Allegheny plateau that can be profitably farmed. The sandy summits termed "Bar-

rens" in many localities occupy all the higher lands, and beneath them the ground is too stony for farming. They are formed by the sandrocks of the Conglomerate Series (No. XII) when its members are friable, but when these sandrocks are hard, with a cement not readily soluble, hard, rough, stony land takes the place of the "Barrens."

The few isolated patches of the Coal measures still left uneroded in the summits, sometimes—as in West Keating—produce very fair farming land, but this soil is apt to be cold and stiff.

The Pocono sandstones (No. X) form all the side slopes, both of the large and small valleys. These hillsides are always very rough, and are occasionally ribbed by lines of vertical and overhanging cliffs which mark the outcrops of the harder layers of sandstone.

In the northwestern part of the county the Lower or Red Pocono (No. X) forms the side-hills bordering the bottom lands, and furnishes a very fair red shale soil, which, though not well adapted to truck farming, yields fair crops of the more hardy cereals..

Elevations of the mountain crests in Clinton county cannot be given, but a few approximate barometric determinations will be found in the township geology. The following railroad elevations are reproduced from Report N.

Philadelphia and Erie Railroad Levels.

Miles.	Station.	Feet above ocean.
0	Sunbury,	444
13	Milton,	473
37	Williamsport,	527
52	Jersey Shore,	593
57	Pine,	565
60	Wayne,	572
65	Lock Haven,	556
69	Queen's Run,	584
70	Farrandsville,	583
75	Furney,	594
78	Glen Union,	605
80	Wetham,	619
83	Ritchie,	632
86	Hyner,	644

89	North Point,	659
92	Renovo,	672
98	Westport,	691
102	Cook's Run,	709
105	Keating,	718
107	Wistar,	739
110	Round Island,	755
114	Grove,	772
117	Sinnemahoning,	794
120	Driftwood,	816
129	Sterling,	914
133	Cameron,	964
139	Emporium,	1033
150	Rathbun,	1317
155	West Creek Summit,	1696
160	St. Mary's,	1667
170	Ridgway,	1393
184	Wilcox,	1527
193	Kane,	2014
222	Warren,	1186
251	Corry,	1431
288	Erie Depot,	584
	Lake Erie water-level,	573

Terraces.

§ 4. The sandrocks of No. XII always make distinct terraces or benches near the summits, and it is often by means of these alone that their position can be determined. In fact, not only have they been used to trace these sandrocks of the Conglomerate, but they have been relied upon to greater or lesser extent by all geologists who have worked in western Pennsylvania, Ohio, and New York, for tracing and determining the horizon of any sandrock or conglomerate, over areas where the erosion has not been sharp enough to afford actually exposed escarpments.

In employing this feature for such a purpose, it is always of the utmost importance to understand the nature of sandrock terraces, and be able to determine to which class a terrace should be referred, as an error made through ignorance of terrace topography involves an error amounting to the thickness of the stratum, for in some terraces the bench is on top the sandrock, whereas in others it is beneath the base of the rock.

1st. Terraces of the First Class, or those in which the top of the sandrock forms the flat or bench (Fig. 1) result only when the sandstone or conglomerate is compact, and has a cementing material not readily soluble, or

SANDSTONE TERRACES.

Fig. 1.

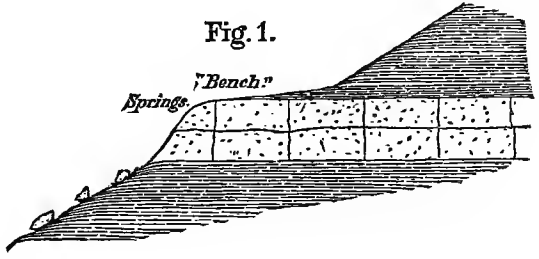


Fig. 2.
ROCK CITY.

Fig. 3.

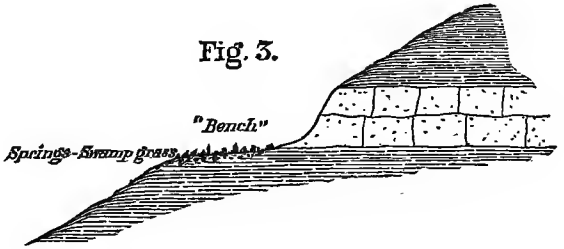
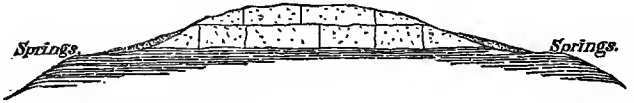


Fig. 4.
BARRENS.



H. Martyn Chance.

O. E. Harden, del.

with a more soluble cement containing a considerable quantity of iron, which on the exposed surface, weathers into an extremely hard and tenacious cement. In a terrace of this kind the surface overlying the sandrock is often swampy, and springs emerging at the top line of the rock trickle down over its escarpment, which usually shows more or less bare rock; but in some cases the rock is full of fissures, letting all the drainage down to its base. As the water will nearly always cut its way a short distance into the underlying shale or slate, the springs will then generally issue from shale or slate a few feet below the bottom of the sandrock. The slope *below the escarpment* is always—except where cleared by glacial action—covered with broken blocks of sandrock or conglomerate.

Rock Cities belong to terraces of this class; for any terrace presenting these features becomes a Rock City when its overlying slate or shale is removed. This change is illustrated by figures 1 and 2, Plate II.

2d. Terraces of the Second Class, or those in which the *shales or slates underlying the sandrock* or conglomerate *form the bench*, always occur when the rock is friable, with but little or an easily soluble cement, or a cement with but slight adhesive power. In terraces of this class the sandrock is eroded *more rapidly than the underlying rocks*, its face receding and leaving a bench in front of it. The soil *on the bench* is composed largely of sand (or pebbles) from the disintegration of the rock, is generally at short intervals quite swampy, and gives rise to a growth of swamp grass and similar vegetations.

Springs always issue at the foot of the sandrock escarpment or nearly on a level with the bench and trickling across it produce the swamps already described.

"*Barrens*" are but a variety of this class of terrace, for wherever the overlying strata are removed, and the sandstone forms the summit, sandy land colloquially termed "*Barrens*" always results. This change is illustrated by figures 3 and 4, Plate II.

Coal and *Limestone terraces* may both be referred to this class, but the latter sometimes belong to the first class

and occasionally present a combination of the features of both classes.

The terrace formed by a bed of sandstone in one locality does not always belong to the same class with that made by the same rock in another place; for the character of the terrace is directly dependent upon the lithology of the stratum, and the latter may vary indefinitely. This change may sometimes be noticed in the opposite side hills of a river valley. In establishing the elevation of a sandrock by its terrace, it is therefore of prime importance to first determine whether the bench represents the top or bottom of the escarpment-forming stratum.

Drainage.

§ 5. As there is very little sub-soil in the country north of the Allegheny escarpment, and as the hillsides are generally quite steep, most of the rainfall quickly finds its way into the small mountain streams, often causing in a few hours a rise of several feet from a rainfall that would produce but a small rise in streams flowing through a country covered with a deeper substratum of soil.

This phenomenon has been of great service to the lumbermen, enabling them to transport logs and timber down very small streams. To facilitate this operation "*splash-dams*" are built across the stream-bed to hold the water back until a sufficient quantity has accumulated, when it is suddenly let out, carrying with it hundreds of logs that have previously been piled lengthwise in the stream-bed below the dam.

The spring and autumn freshets in the Susquehanna river are too well known to need any description. Though often very violent, they are—as in all mountain rivers—of short duration.

The principal streams north of the Allegheny mountains are Queen's run, Lick run, Tangascootack creek, Big run, Backer's run, Hyner's run, Youngwomanstown creek, Paddy's run, Drury run, Kettle creek, Cook's run, and the Sinnemahoning river.

All the drainage of the county empties into the West

Branch of the Susquehanna river, or as it is there called, "the Susquehanna."

The only dividing ridge of any importance is the divide between the drainage into Pine creek on the east (Lycoming county) and the Susquehanna on the west. The eastern boundary line of the county runs along this ridge, following the course of the old Coudersport and Jersey Shore turnpike. This pike, now for many years abandoned as a public highway, has lately been utilized as a location for the Tidewater Pipe Line, running from the Bradford oil field, at Eldred, to Williamsport.

A dividing ridge of minor importance, though the highest in the county, runs from Hyner, southwestwardly, towards Karthaus. It marks the position of the Hyner anticlinal axis. Its crest is often 1500′+ above river level.

The drainage system south of the Allegheny mountains is rather complex. Bald Eagle valley is drained by Bald Eagle creek and the Susquehanna, both of which flow over the eroded edges of the limestones of No. VI.

Sugar and Nittany valleys are drained by Fishing creek, which, rising at the eastern end of Sugar valley, flows westwardly to a sharp deeply cut gap, through which it passes into Nittany valley from whence it finds its exit at Mill Hall Gap.

The stream at Wayne gathers its waters exclusively from the mountains between Nittany and Nippenose valleys.

The drainage of Nippenose valley all passes out through Nippenose Gap.

Soil.

§ 6. The arable soil of the county may be conveniently divided into four classes.

1st. The limestone and slate lands of Nittany, Sugar, Nippenose and Bald Eagle valleys on which cereals do excellently well and which also make very good grazing land.

2d. The Red Shale lands of Bald Eagle valley formed by the Red Catskill; and those of the northwestern part of the county, made by the Red Pocono strata. Wheat and

corn do well on these lands; and where they are rather stony buckwheat can be raised.

3d. The high lands of the Conglomerate measures and the Lower Productive coal measures. Only a comparatively limited area of these lands is profitably arable.

The relative areas of these different soils can be readily seen by examining the geological map on which the blue color represents limestone, and the dark tint of Payne's grey shows the area of the Coal measures.

4th. The Bottom lands along all the larger water courses. These are too well known to need any encomiastic description. Their excellency along Bald Eagle creek is partly due to the presence of the Upper Silurian limestones, and the calcareous strata at the base of the Marcellus slates which form a series of low foot-hills on the north side of the flats.

All of the county not embraced under any of the foregoing divisions is worthless for agricultural purposes, being too stony or precipitous for cultivation. Under this head come the mountain ranges in the southern part of the county, formed by the Medina and Oneida sandstones (No. IV) and all the steep rocky slopes and side hills of the Allegheny mountains plateau, formed by the outcrops of the Pocono sandstone No. X.

The great industry of the county has been and still is the lumber trade; especially the manufacture of pine lumber. Though the output in some late years from this region has been very large, there is comparatively little good pine timber now standing. Probably much more than three-fourths of it has already been cut, and that now remaining is not equal in quality to that which has already been marketed.

On the north branch of the Tangascootack, and northward to the river at West Keating township, there still remain, in isolated groves, some good sticks, and in West Keating township some excellent groves have been preserved, but these are now being taken to market, and shortly little will be left.

On the north side of the river in Noyes, Chapman, and

Leidy townships the good timber has been pretty thoroughly cleared out. This is probably owing to the facilities afforded for transportation, by the waters of Kettle creek, Paddy's run, and Youngwomanstown creek. A few good pine sticks are still to be seen in these townships, and will probably remain standing until an advanced price in lumber tempts the owners to part with them. Of timber other than pine there is an abundance, but with the exception of hemlock and some oak it is generally rather too small to cut.

Near Westport and on Cook's run some excellent pine, hemlock and oak lands yet remain in a comparatively untouched state, but their area is not large. They are owned by Williamsport companies.

Ores.

§ 7. The only ore ever discovered north of Bald Eagle mountain is iron ore. Crystals of galena have sometimes been met with, and fragments of copper are said to have been found, but these were either transported thither in the drift or owe their presence to the Indians or white men. Cubes of galena, it is true, have been found in the Coal measures, but they are always isolated, and cannot be classed as an ore. Their origin has never been satisfactorally explained. Though traces of copper ore—*malachite* and *crysocolla*—have frequently been found in the Red rocks of No. IX in Pennsylvania, *native copper* is not found in rocks of this age.

Ore of XI (X).

At Farrandsville two ore beds have been opened, but they are not of very good quality, and could not be profitably worked beyond "striking distance." These beds have, by some, been referred to the Mauch Chunk red shale, No. XI, but I have classed them in the Pocono, placing the lower limit of No. XI some distance above them. It is true that these beds occur with beds of red shale, but the latter are quite thin, and underlie sandstones of the true Pocono type, and as *thin bands* of red shale *may* occur at

any horizon in the Pocono, it seems more consistent to place them in that formation. If they are the equivalents of the ore of No. XI in the southwest, they should be found immediately beneath the conglomerate;—near the top of the Umbral (XI) and not three hundred feet beneath it.

Ores of VIII and VII.

Neither the *Oriskany* ores nor the *Marcellus* ore bed has yet been found.

Ores of V.

§ 8. At Mill Hall Gap two ores of the Clinton red shale (No. V) have been opened and worked by the Mill Hall Furnace Company: the *fossil ore* and the *block ore.* The first of these was from 10″ to 1′ thick, and was used more largely than the block ore, which, however, is somewhat thicker, but quite siliceous. Frequent attempts have been made to discover the fossil ore between Mill Hall Gap and Jersey Shore, but the bed is either quite thin or absent. Local developments may, however, be discovered in the future, which will prove valuable; but at present it does not appear that much should be expected from this bed.

Ores of II.

§ 9. These are confined to the limestone valleys of No. II: Nittany, Nippenose, and Sugar valleys. They have been mined in Nittany valley, at Salona and Clintondale (Washington furnace), in Sugar valley, at Freedley ("Old Deborah") furnace, and at the old furnace in Nippenose valley.

A very careful study of these Nittany valley ores was made by Prof. J. P. Lesley for his report upon the lands of Lyon, Shorb & Co., in Huntingdon and Centre counties, in 1873, and published in the proceedings of the American Philosophical Society, Vol. XIV, from which the following extracts are taken:

"The rocks of the Lower Silurian Age were originally sea-muds, composed of rounded grains of dolomite (derived from previously existing Lawrentian land), cemented together with a paste of carbonate of lime. Some of the

beds consisted also of rounded grains of quartz. Some of the layers were nearly pure carbonate of lime. All contained a larger or smaller percentage of iron, lead, zinc, and other metals, precipitated either chemically or by the agency of organic beings, from the solutions of their carbonates, chlorides, etc., in the river and sea-waters. The orderly explanation of all the chemical and organic features of this complicated operation is yet to be given to the scientific world; but all will agree that the general character of the calcareo-ferruginous muds, the sediments of that early geological age, must have been as above described.

"During the long Upper Silurian, Devonian, and Carboniferous ages, these Lower Silurian sediments were buried to a depth of over 16,000 feet beneath the later sediments. They remained wet. Their great depth raised their temperature 16,000 ÷ 50=320° (Fahrenheit's thermometer)which added to the mean temperature of the surface, would keep them under the influence of a moist heat of nearly 400° F., through what, to man, is a small eternity of time.

"Dr. Genth's discovery of the amorphous or gelatinous condition of a part of their silica is thus explainable. Varied reactions must have ensued. The carbonate of lime and magnesia combined as dolomites, which in part crystallized in rhombohedral crystals, the forms of which we now see, in the outcrops, emptied by dissolution. The iron became peroxydized as *fibrous* hematite, and the silica can be obtained by dilute nitric acid *in the same fibrous form.* All this points to the first formation of the iron ore, while the rocks were still at a great depth, wet and soft and warm.

"But at the end of the coal era the Middle States rose from the waves and have never been covered by the ocean since that time. Erosion commenced and has continued . . . . to the present day, and still goes on. The high plateau was gradually worn down to the present surface. Mountains once 30,000 or 40,000 feet high are now but 2,000 or 3,000 feet above sea-level. The valleys were excavated as the mountains lowered, and the outcrops of the Lower

Silurian limestones of Nittany valley are but 800 to 1300 feet above tide.

"This slow erosion [of the limestone valleys] gives us the second part of our explanation of the brown hematite iron ores. It explains the innumerable caverns and sink holes and dry hollows of this Nittany and other limestone valleys. It leads us to expect to find traces of such caverns and widened fissures and sink holes of the last preceding age, filled up with a wash of clay, sand, and iron ore from outcrops lately existing not far above the outcrops which run along the present surface.

"The erosion still going on, ... may very well explain that outspread of surface wash-ore which makes so large a feature of the case. It may also explain the corrugations of the clay and ore strata in their superficial wash-ore deposits.

"Thus the different theories in vogue among our iron men are harmonized. Each theory has its own basis of truth, its own set of facts, but does not embrace all the phenomena.

"Those who contend that the brown hematites lie in pockets are correct; but they must confine their assertion to that part of the ore which now occupies former caverns, fissures and sink holes.

"Those who contend that the brown hematites are surface washes caught by the accidental variations of the earth's surface, are correct; but they must limit the application of their theory to banks which show rolled gravel and rolled ore, and a confused and mingled mass of ore, sand and clay.

"A third view is equally correct and much more important. It must be accepted as probable, that in spite of later movements, and in addition to cave-deposit ores and surface-wash ores, there are interstratified beds of brown hematite, still in their original places, although not in their original condition, descending with the general slope of the formations between undissolved limestone, dolomite and sandstone rocks to undetermined depths, and ranging lengthwise of the district, so that rows of ore banks can be

and have been opened in continuous belts of many miles' length, and on continuous outcrops of ore ground of every conceivable variety of character, quality and quantity.

"It is provable . . . . . that there exists several of these belts, representing different *geological horizons;* and due to an extra charge of iron, given, we know not how, to sediments of different ages. As, on a grand scale iron-bearing rocks occur at various stages of the column of Palæozoic rocks from No. I, Potsdam SS., to No. XII, Coal measures,—so, within the narrower limits of one sub-division of this column, viz., in the Lower Silurian System, iron-bearing rocks occur at various stages, separated by from 500 to 2000 feet."

As the brown hematite ores of Clinton county occur in the same formation and are continuous with the above described ores, the following extracts from the same report upon the "Practical Value of the Ores" are in place here.

"The experience of sixty years has demonstrated the exact values of the brown hematite ores of all the Lower Silurian valleys of Pennsylvania.

"The general resemblance of ores from all the banks is striking. The local variations are still more striking. The key to those variations was only got when the true geological theory of structure was studied out. But it is still a perplexing question why the red-short, cold-short and neutral ores should lie so near each other. There is scarcely an ore-bank in Pennsylvania in which the chemist will not find some infusion of sulphur and phosphorus. But some ores have been so slightly charged with one or other, or both of these elements, that they rank in the first class.

"Others are so heavily charged that they are useless for Bessemer work; take a low rank as anthracite or coke iron ores, and only make good pig when smelted in small quantities, with charcoal and a feeble cold-blast.

". . . Most of the ores of the district under notice here yield a practically neutral ore, and make the best possible iron in cold-blast charcoal furnaces, and good iron with the hot-blast, and mineral fuel.

"Phosphorus, however, is found in all known Silurian

brown hematite ores (with some rare exceptions) in quantity enough to prevent the manufacture of steel. But in some cases mixture with other ores will rectify the ore. In other respects the percentage of phosphorus is too small to do hurt.

"There are parts of the deposit in almost every bank, which are sandy and lean. These have been hitherto fastidiously rejected by the charcoal cold-blast furnaces of the district. Such ores are, however, in demand for our anthracite and coke furnaces, and the ever-increasing market for them will require the mining of the whole. I believe that carefully selected ore from these banks will even furnish iron fit for Bessemer use."

The percentage of phosphoric acid in these ores rarely reaches 00.50, though occasionally it amounts to nearly one per cent. The amount of phosphorus in 100 parts of iron will usually range between 0.15 and 0.35.

Chapter II.

Systematic Geology.

§ 10. The sections measured in Clinton county are all given in Part II, in the report on the Sub-Carboniferous rocks, and reference must be made to them for all details of measurement and description.

The Lock Haven Long Section (Chap. X) gives the thicknesses of all the strata included between the Lower Silurian rocks of Nittany valley and the Coal measures of the Alleghenys.

The following scheme gives (without thicknesses) the arrangement of the Palæozoic rocks and the nomenclature used throughout this report. The left-hand Roman numerals show the numbers of the First Survey, while the names opposite them are the ones adopted by the Second Survey. Most of these latter have been borrowed from the New York nomenclature, but some, as Mauch Chunk, Pocono, etc., are taken from well known localities at which the formation designated presents a typical development.

All of the accompanying Palæozoic column of Pennsylvania rocks is represented within the limits of the county except the Potsdam sandstone No. I, the bottom rock of the system, which underlies the limestones of Nittany valley, and although not brought to the surface by the Nittany valley anticlinal, it cannot lie very far beneath water level along the crest of that flexure.

The Lower Productive Coal Measures remain uneroded, but the Barren Measures and the Upper Productive Coal Measures have been swept off this and the adjacent counties.

Lower Productive Coal Measures.

§ 11. The best areas of coal remaining uneroded in Clinton county are found in West Keating twp.; near Westport; on the Tangascootack; and at Queen's run, Farrandsville and Eagleton.

Column of Palæozoic Rocks.

CARBONIFEROUS AGE.

No. XV. Upper Productive,
No. XIV. Barren, ... } Coal Measures.
No. XIII. Lower Productive,
No. XII. Conglomerate Measures.

SUB-CARBONIFEROUS AGE.

No. XI. Mauch Chunk red shale (Umbral of Prof. Rogers).
No. X. { Pocono Upper(gray)sandstone, } (Vespertine.)
{ Pocono Lower (red) sandstone, }

DEVONIAN AGE.

No. IX. Catskill (Ponent).
No. VIII. { Chemung.
Portage.
Hamilton. (Genesee, Hamilton, Marcellus).
Upper Helderberg group.
No. VII. Oriskany sandstone.

SILURIAN AGE.

No. VI. Lower Helderberg group, } Upper Silurian.
No. V. Clinton group, ... }
No. IV. { Medina sandstone, . . . } Middle Silurian.
{ Oneida Conglomerate,. . }

SILURO-CAMBRIAN.

No. III. Hudson River and Utica slates.
No. II. Trenton, Birdseye, Black River, etc., limestones.
No. I. Potsdam sandstone.

The geological map shows many isolated patches covered by the Coal measure rocks, but many of these contain only the *lowest coal seam*, which often has so little cover that profitable working is impossible.

The Tangascootack coal field contains three beds, of which one only can be profitably mined, and most the easily accessible area of this bed has been exhausted. The same statement is equally true of the Queen's run and Farrandsville coal. The bed was here cut off by a square-cut fault, supposed to be an upthrow. Mr. Platt has suggested that this may be a downthrow, and recent excavations showing *soft shales* at the face seem to indicate that such is the case. If so, then a considerable body of coal may yet be obtained from this locality.

The fireclay immediately underlying this coal made excellent firebrick, and should the coal be found beyond the fault these brickworks could again be profitably operated.

The Eagleton mines were not nearly exhausted when abandoned, but much of the coal was ruined by injudicious mining. Years hence, when the coal supply is insufficient to meet the demand, this area may again be opened up and worked, but at present it would be difficult to find a market for the coal.

The small coal areas near Wetham and on the old Coudersport and Jersey Shore turnpike, though containing a seam from two to three feet thick, have hardly sufficient cover to insure clean coal.

The developments made near Renovo between Drury and Shintown runs have resulted disastrously. They are described by Mr. Ashburner in chapter V.

In West Keating township some very fair coal has been opened up. The best areas are found between Grove run and Three runs. These coals may furnish a considerable quantity of fair coal, but in the absence of a railroad they cannot be profitably mined.

The Wistar coal lands contain only the lowest coal seams with very little cover. Prospecting is now (May, 1880) being done with but little prospect of obtaining a profitably workable bed.

The best coal seam opened in Clinton county is to be seen near Westport on the dividing ridge between Kettle creek and Little Cook's run. It measures from four and a half to five feet, is clean, free from slate and shows but a moder-

ate amount of ash and small percentage of sulphur. A large colliery will probably soon be in operation at this point. A detailed description of the bed will be found in the geology of Noyes township.

Coal Measure ores.

§ 12. But little attention has been given to the Coal measure ores in collecting the data for this report. They are all carbonate (clay iron stone) ores *weathering at the outcrop into brown hematites* so that most *the surface specimens deceptively indicate the presence* of rich hematite ores. The nearness and abundance of the limestone ores of Nittany valley which far surpass these coal measure ores in purity and in the percentage of iron and which must always completely overshadow them will always prevent the profitable mining of these ores.

Conglomerate Measures, XII.

§ 13. These sandstones and conglomerates form the caprock to nearly all the summits north of the Allegheny escarpments. They number sometimes two, sometimes three or four bands of coarse sandstone, separated by beds of sandy shale, in which thin coal seams may occasionally be found. They are described in detail, in Part II.

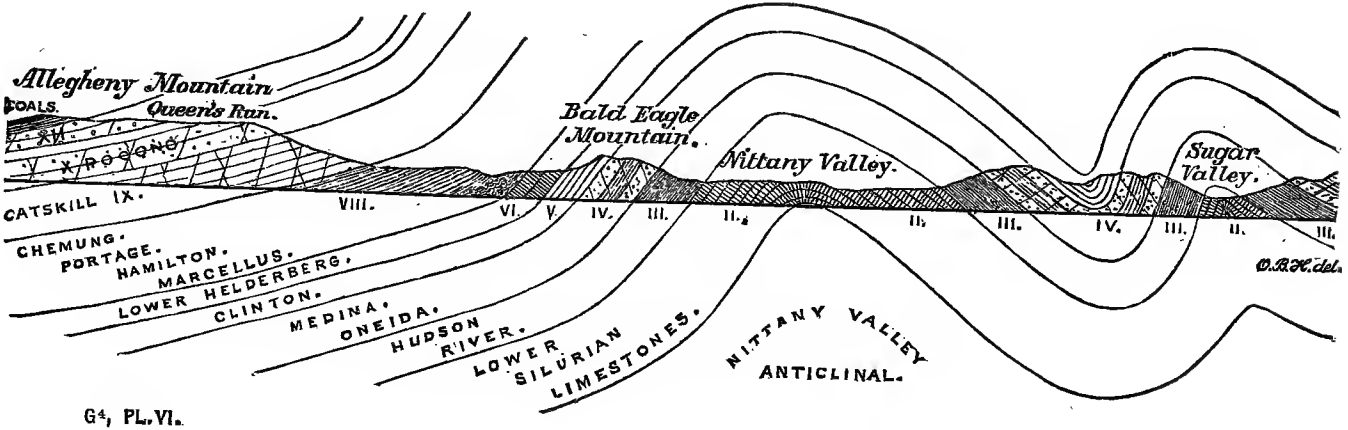
The area covered by these measures is shown by the tint of Payne's grey, next above the red line of No. XI, and immediately beneath the dark coal areas.

Mauch Chunk red shale, No. XI.

§ 14. This is shown by a red line running around all the summits north of the mountainous escarpment. This red line does not strictly represent what is actually found on the ground, for sometimes no trace of this red band can be detected. Over such areas the line has been prolonged as if the formation it represents were actually existant, and is located to show as nearly as possible, the true horizon of that formation.

Plate VI will show to the eye the manner in which these formations lie, superimposed one upon the other in regular

PROFILE SECTION FROM QUEEN'S RUN TO SUGAR VALLEY.



G4, PL. VI.

order; and it will also show at a glance how the Nittany valley limestones lie far beneath the rocks at Queen's run.

Pocono sandstone, No. X.

§ 15. The two divisions of this formation, grey and red, can be discerned without difficulty from Hyner, or North Point northwardly and westwardly to Cameron and Potter counties, but from Queen's run to Hyner, it is very difficult to place the dividing line between the two sub-divisions, as the lower half contains very little red rock. (For sections, and detailed description of this formation, see Part II.)

The hillsides from water level up to the red shale of No. XI, are composed entirely of Pocono measures, (grey and red,) except on the anticlinal crest at Hyner and Ritchie, where more than two hundred feet of Catskill red rocks come above water level.

Catskill red rocks, No. IX.

§ 16. Mention has been made of the occurrence of this rock at Hyner. It is also seen finely exposed at Queen's run. Traced eastwardly and westwardly from the latter point, it extends along the foot of the Allegheny mountains, always forming bold, rounded hills, whose red soil is conspicuous, even when viewed at a distance of several miles.

Devonian grey rocks, No. VIII. (Chemung, Portage, Genesee, Hamilton, Marcellus.)

§ 17. These rocks are all finely exposed on the Susquehanna, between Lock Haven and Queen's run, where they were measured, and are described in the Lock Haven section, (Part II.)

They form the rolling country of the northern half of Bald Eagle valley, and the high rounded knobs generally known as the "Allegheny Mountain Foot-hills."

Other than furnishing some flag-stone, they contain nothing of economic importance.

Oriskany sandstone, No. VII.

§ 18. This rock is absent from the eastern part of Bald

Eagle valley. It occurs near Beech creek, but is evidently quite thin and can hardly be of much value. It is possible however that search properly directed may result in the discovery of some layers sufficiently pure to yield a good glass sand.

Lower Heldelberg limestones, No. VI.

§ 19. Of these little can be said. They are generally eroded and far out of reach beneath Bald Eagle creek and the Susquehanna river. Where exposed and quarried they yield a lime far inferior to the Nittany valley limestone, though for agricultural purposes one is probably as good as the other.

Clinton red shale, No. V.

§ 20. This is found along the northern slope of the Bald Eagle mountain and in the synclinal valley of Cherry run between Nittany and Sugar valleys. It is the repository of the famous "fossil-ore" of the Juniata country. This ore has been opened and worked at Mill Hall gap but it was quite silicious and was finally entirely superceded by the brown hematite from Nittany valley.

Medina and Oneida sandstones, No. IV.

§ 21. These massive sandrock deposits are of little interest to the economist. They form the bold mountain ridges in the southern part of the county.

At Lock Haven these sandstones together with Nos. V, VI, VII, and VIII dip northwest beneath the Allegheny mountain rocks and are not again visible until they come above water level in New York State, one hundred miles to the northwest.

Hudson River and Utica slates, No. III.

§ 22. These soft shales and slates sometimes containing quite sandy layers, everywhere flank the mountain between the limestones of No. II and the hard sandrocks of No. IV.

In the eastern part of the State this formation supplies

us with an inexhaustible supply of roofing slate, which only occur in those parts of the formation that have been twisted and distorted by enormous pressure, and which has produced in them a set of cleavage planes entirely independent of the original bed plates. The slates split up into thin sheets along these planes and at an angle to the bedding. As these conditions are absent in Clinton county it does not seem probable that slate fit for roofing will ever be obtained from this formation.

Siluro-Cambrian limestones, No. II.

§ 23. Of these limestones themselves but little need be said; and their ores have already been described. The formation is represented by the cobalt blue color on the geological map. It is characteristically valley forming, and these valleys are always full of sink holes, caverns, fissures and underground streams due to the solvent action of rain water loaded with carbonic acid gas upon the limestone.

Potsdam sandstone, No. I.

§ 24. This formation underlies the above described limestone series, but does not appear above water level in Clinton county. Its depth beneath the water level in Fishing Creek near the center of Nittany valley is probably more than 1000 feet.

Chapter III.

Structural Geology.

§ 25. The topography of Clinton county is intimately in relation not only with the stratigraphical but also the structural geology of the county.

In the southern part of the county, *i. e.* that portion south of the Allegheny escarpment, the limestones of No. II are elevated above water level along the crests of two major anticlinal axes; the Sugar valley axis and the Nittany valley axis. These two axes include between them the synclinal of Nittany mountain.

Besides the main axis of Nittany valley one or two subordinate rolls, the eastward prolongations of more prominent western flexures, can be faintly detected near the Centre county line.

The Nittany valley axis lies on the north side of the valley, but a short distance from Bald Eagle mountain, its north dip being steep, its southern dip more gentle. These features will be more easily understood by reference to the page plates showing cross sections of Nittany and Sugar valleys.

Nippenose valley also owes its existence to the Nittany valley anticlinal as well as the beautiful little Musquito valley of Lycoming county.

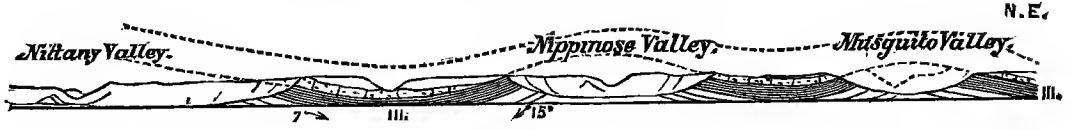
The existence of this axis would not have produced these valleys were the crest of the flexure a straight line; but this crest is a curved line, raising the formations in a succession of domes. The accompanying page plate is a reproduction of the cut given in the report of the First Survey to illustrate this feature.

The north dip of the Nittany valley axis is much sharper than the south dip. The same statement is equally true of the Sugar valley axis.

The synclinal of Big mountain, or Nittany mountain as it is also called, broadens out to the east towards Lycoming

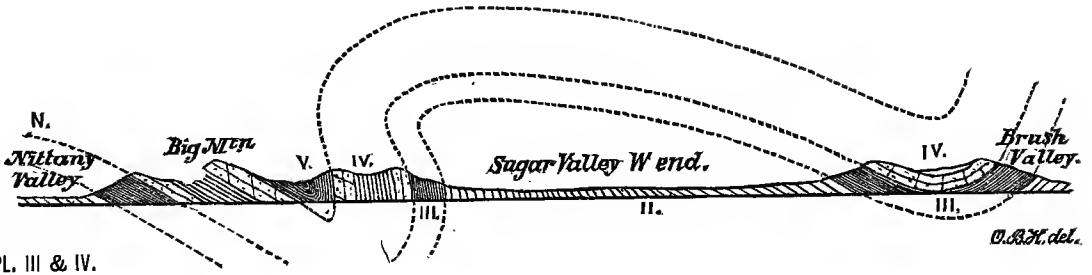
SECTION ALONG THE NITTANY VALLEY ANTICLINAL.

Reproduced from the First Survey Report.



SECTION ACROSS NITTANY & SUGAR VALLEYS

Copied from the First Survey Report.



G⁴, PL. III & IV.

county, and contracts toward the west. It includes between its two crests the valley of Cherry run, and Pleasant valley in Centre county, where a notable thickness of the red shales and sandstones of No. V, remain uneroded.

The broad table-land between Nittany and Nippenose valley is formed by a nearly horizontal expanse of No. IV. Some little red shale of No. V here and there remains as a cap rock, but its area is limited.

§ 26. Bald Eagle valley presents several minor anticlinal folds. These are all confined to the flat country bordering the northern flank of Bald Eagle mountain, and occupy a width of about one mile. They are well exposed in a series of limestone quarries, natural exposures, and road cuttings on the east side of Pine creek.

Plate V (chapter IV) shows a section measured and constructed at that locality.

At Mill Hall Gap the space occupied by these folds is not nearly so broad as at Pine creek, and the valley flats are consequently much narrower. This narrowing continues to the Centre county line, with probably a partial disappearance of the flexures.

Between Lock Haven and the Allegheny mountains, at Queen's run, the dip is constantly to the northwest, varying in steepness from 50° to 85° to 45° to 38°, to 19° to 14°, to 10° to 5°, when the center of the Tangascootack basin is reached, and the pitch is reversed for several miles.

Axes of the Bituminous Coal Field.

§ 27. North of the Allegheny escarpment the following anticlinals and basins have been located, and traced east and west to their connections with flexures described in adjoining districts.*

[Driftwood or Second anticlinal axis.]

Renovo-Karthaus Basin.

Hyner anticlinal axis.

Wetham Basin.

Eagleton anticlinal axis.

Tangascootack-Queen's Run Basin.

* See Reports of Progress in Clearfield county, H, Lycoming county, GG, and Potter county, GGG.

Tangascootack Basin.

§ 28. This trough extends from the wilderness of Beech creek and the headwaters of the main branch of Tangascootack creek, east by north; crossing the river near Farrandsville, and continuing eastward close to the southern face of the mountain, until Pine creek is reached. East of Pine creek, in Lycoming county, the Conglomerate (XII) and most of the Pocono sandstone (X) have been eroded from its site, so that it is no longer a flexure in the Coal field, but runs in front of the Allegheny mountain in a narrow belt of red Catskill rocks (No. IX) as shown on the map of Lycoming county, Report GG. It has no connection whatever with the coal basins of Sullivan county (see Report GG) as formerly supposed, and as indicated on the State map of 1858.

Tracing this basin westwardly we would naturally look for its continuation in the southern part of the Snow-Shoe trough, but from the course of the basin, as determined from points located on the Clinton county map, it appears that when prolonged, this basin should be found much farther south, or nearer the face of the mountains than the Snow-Shoe district. It is possible, however, that the maps are faulty, and that were the course of the trough accurately determined, it would be found continuous with the latter basin.

Eagleton or Furney's Run Anticlinal.

§ 29. In going northward up the P. & E. R. R. from the Tangascootack basin near Farrandsville, the strata rise on a nearly uniform south dip of about 100 feet per mile until Furney's run is reached. Here an anticlinal crosses the river. This produces the high lands east of Furney station and west of the run near Eagleton.

Its north dip is slight, and the Wetham basin next north of it being quite shallow, it is hardly more than a roll or slight fold on the south side of the more prominent Hyner axis.

Eastward the anticlinal broadens out and becomes sharper

until in Bradford county it is quite a prominent axis, marked by a broad valley. Its crown is detected near Wyalusing Falls.

Wetham Basin.

§ 30. At Wetham one or two of the lower coals are brought down into the hilltops by this trough, which is again detected on the eastern boundary line of the county in Gallauher township, where it contains one,—possibly two, coal beds. Their area, however, is quite limited. The patches of coal land lying west of Eagleton are also to be referred to this basin, which is the eastern extension of the northern part of the Snow-Shoe basin. Traced north-eastwardly it apparently broadens out into the Towanda Mountain synclinal, from which the Towanda coals are mined.

Hyner Anticlinal.

§ 31. This is the most important axis of the county. Its crown is exposed on the railroad, midway between Hyner and Ritchie stations, where it brings over two hundred feet of Catskill red rock above water level.

It extends southwestwardly, forming the high lands south of Renovo, which in some places are 2100′+ above ocean level (bar.), and passing into Clearfield county subdivides the First Basin of the southwest, into two troughs; the Snow-Shoe, and the Karthaus sub-basins.

It is the representative of the main sub-axis of the First Bituminous coal basin, Mr. Platt's Viaduct axis, though not necessarily continuous with that axis in a straight line.

Tracing it northeastwardly across the high lands capped by the Conglomerate and Pocono sandstones in Clinton and Lycoming counties, we find it gradually passing into and lengthwise through a broad lowland; for, the gradual elevation of its central line brings up to daylight, in Lycoming county, the soft red rocks of the Catskill, and the easily eroded Chemung and Portage shales. In Tioga and Bradford counties it is practically represented by the axis

which runs through the centre of the valley between the Towanda and Blossburg mountains.

Karthaus-Renovo basin.

§ 32. This is nearly parallel to the Hyner axis. In West Keating township it contains some good workable coal beds, but the attempt to mine from it at Renovo was financially unsuccessful.

The north dip into this basin from the crest of the Hyner axis is steeper, averaging about 200 feet per mile in the vicinity of Hyner's run and Youngwomanstown creek.

The Blossburg basin in Tioga county is apparently a continuation of this trough, and is therefore the northeastern extension of the second sub-basin of the First Bituminous coal basin of Clearfield and Cambria counties.

The "First Axis."

§ 33. From the centre of the synclinal trough on the Sinnemahoning river near Keating station, northward to Driftwood there is no indication of the presence of any flexure, the rise to the north being continuous (south dip) until the crest of the Second anticlinal axis is reached near Driftwood. The First anticlinal axis, as determined by Mr. Platt in Clearfield county, should, when prolonged to the Sinnemahoning, cross the railroad about ten miles above Keating; but no axis can be detected in that vicinity, though it may be represented by a flattened, indistinct roll.

The disappearance of this axis was suspected by Mr. Platt, who in his first report (H, page 11) says: "The Laurel Hill [First] axis in Clearfield county . . . . crosses . . . . the West Branch of the Susquehanna west of Frenchville, about 5 miles west of Karthaus . . . . and . . . . is much flattened out and seems to be dying gently away to the northward."

It is then clear that northeast of Clearfield county the *First axis* of the southwest *has no existence*, and with it the *second basin becomes extinct*, having its place upon the south slope of the second or Driftwood anticlinal axis.

The following scheme, though simply a *resumé* of the above descriptions, will show more clearly the synonymy of the local names used to designate these basins and axes. The names "First," "Second" and "Third" axis (or basin) are used to denote the divisions recognized in Cambria and Clearfield county. When enclosed in brackets, they express the nomenclature used by Mr. Hodge, of the First Survey, for the flexures determined by him in the northeastern counties.

The First Bituminous coal basin of the southwest is the geological and geographical equivalent of the Laporte, Towanda and Blossburg basins of the northeast.

The connection existing between the Wetham and Queen's Run basins in Clinton county and the Snow Shoe sub-basin was not accurately determined by the work done in Clinton county, but the data obtained by Mr. Platt in Centre and Clearfield counties will probably minutely determine the location of these troughs and their course southwest to the Snow Shoe coal field. Enough is known however to make certain the identity of the Hyner axis with the Viaduct or First sub-axis, though in all probability the axis does not continue for any great distance in a perfectly straight line, but runs in a curved line or *in échelon* along the course already described.

The northeastern extension of these flexures through Bradford and Tioga counties has already been very fully described in Reports G, GG and GGG by Mr. Platt and Mr. Sherwood, but the facts then in hand were not sufficient to fix their exact equivalency with the folds of southwestern Pennsylvania, and local names were therefore given them; these latter are shown on the right hand side of the table.

All the Coal measures of Clinton county are referable to the First basin of the southwest. It must not be inferred from the above identification that all these axes and basins run continuously as such through the State from Tioga to Cambria county. The scheme presented is only of use for comparison and collation of the material published on then widely separated districts and is only intended to show the homologue in one district of an axis or basin described in

Correlation of the Axes of the Bituminous Coal Field in Clinton County, with those described in previous reports upon adjoining counties.

South-west.	Clinton County.	North-east.
Third Basin,		Crooked Creek synclinal [Fourth Basin].
Second Axis,	Driftwood Axis,	Wellsborough anticlinal [Third Axis].
Second Basin,	Wanting,	Wanting.
First Axis or Laurel Hill anticlinal,	Wanting,	Wanting.
First Basin, Second sub-basin, Johnstown,	Karthaus-Renovo Basin.	Blossburg Basin [Third Basin].
First Basin, Viaduct or First sub-axis,	Hyner anticlinal axis,	Towanda Axis [Second Axis].
First Basin, First sub-basin,	Wetham Basin,	Towanda Basin [Second Basin].
First Basin, First sub-basin,	Eagleton Axis,	Wilmot anticlinal [First Axis].
First Basin, First sub-basin,	Queen's Run Basin,	Laporte Basin [First Basin].

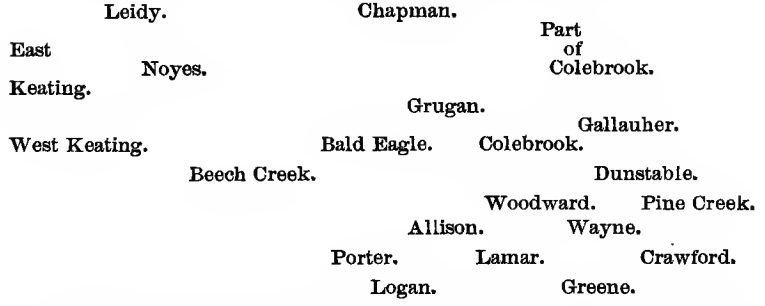
[Note.—The above table must not be taken for more than it is worth. It must be carefully remembered that the Queen's run basin points down into the Williamsburg valley, and not towards the Laporte basin; but it occupies the same *relative* position in regard to the basins back (northwest) of it, as the Laporte basin does to the basins back (north) of it.—J. P. L.]

another county. It also graphically displays the incompetence of a numerical nomenclature to express the facts of structural geology; thus the "First Basin" of the southwest is made through an erroneous nomenclature the equivalent of the First, Second and Third basins of the northeast and of the First and Second basins of Centre and Clearfield counties.

Chapter IV.

Geology of the Townships.

§ 34. The townships of Clinton county are twenty-one in number, arranged irregularly in the following order:



They will be described in the following pages in regular order from east to west beginning at the southeastern corner of the county and progressing northwardly to the northwestern corner.

Much of the material used for the report on the townships south of the Bald Eagle mountain has been taken from the report of the First Survey. Mr. Platt has furnished some valuable data for the report on the Tangascootack, Beech creek and Queen's run coal fields.

Greene Township.

§ 35. This is a wedge shaped tract—its sharp end pointing east—lying in the southeastern corner of the county adjacent to Lycoming and Centre counties.

Its northern half is occupied by part of the mountainous plateau of Nittany mountain, containing the eastward ex-

tension of the Cherry run synclinal, while in its southern half lies the fertile limestone country of Sugar valley, bounded on the south by Brush mountain.

As Sugar valley is best described as an individual whole, the detailed geology pertaining to it will be placed after the description of Logan township.

Logan Township.

§ 36. This lies next west of Greene township, and south from Porter and Lamar townships. Its northern boundary line follows the centre line of Cherry valley.

It includes therefore in its northern portion one half the red shale lands of Cherry valley and the southern crest or half of Nittany or "Big" mountain.

These red Shale lands of No. V are covered with *talus* from the hard sandrocks of No. IV in the adjoining mountain and are worthless as farming land.

Washington furnace obtained much of its fuel from this valley. A railroad three or four miles long was built up this valley to transport charcoal to the furnace.

Sugar Valley.

§ 37. This beautiful and fertile canoe-shaped limestone valley is from one to one mile and three-quarters wide and about seventeen miles long.

It is surrounded on all sides by the mountains formed by the outcrop of No. IV,—the Oneida and Medina sandstones. Between these and the limestone floor of the valley is a band of slaty and shaly measures (No. III) forming the mountain flank. Very fair land often results from a disintegration of these measures when free from the debris of mountain sandstone with which they are usually covered.

The anticlinal which elevates the valley-forming limestones of Sugar valley gently dies away at both the eastern and western ends of the valley. The greatest thickness of limestone is therefore brought above water level near the centre of the valley.

Plate IV, shown on the same page with plate III, is reproduced from the report of the First Survey, and shows the connection underground of these limestones with the limestones of Nittany and Brush valleys, and how the sandrocks of Brush and Big mountains are parts of one and the same formation.

The drainage of Sugar valley is not nearly so irregular as that of Nippenose and Nittany. Sink-holes and underground water courses are more rare. The whole valley is drained by Big Fishing creek which rising at the east end of the valley flows westwardly through its whole length, keeping near the centre of the valley and finally flows into Nittany valley through the sharply cut and tortuous gap at Washington furnace.

Ore.—The ore worked by Freedley ("Old Deborah") furnace was dug near the eastern end of the valley. Great difficulty was experienced in keeping out the water, and this finally led to the abandonment of the enterprise. The stack has been out of blast for nearly thirty years.

§ 38. The following paragraphs are extracted from the final report of the First Survey, 1858.

"Iron ore is supposed to exist in quantity three miles west of Kleckner's, but other openings have failed to yield ore enough to justify the erection of furnaces. About two miles east of Kleckner's the surface is strewn with specimens of dark excellent chestnut ore, among numerous fragments of variegated chert. In every opening the solid rock was struck before descending 15 feet, and shafts 30 feet deep were sunk near the furnace with the same ill success.

"On the road from Rebersburg into Sugar valley the Levant Grey sandstones (No. IV) at first dip 45° N. 28° W., and there in the middle of the synclinal we find the complexly false-bedded strata of the argillaceous (red) sandstone in a nearly horizontal position. The Matinal (No. III) slates, on entering the valley, dip 45° S. 30° E. This is three miles from its west end. Pursuing the road across the valley to Washington gap, the limestone strata incline continually less, and a dip is perceived lengthwise of the anticlinal as the latter declines westward. Before reaching

the saw-mill the dip is 5° S. 40° W. At the saw-mill it is but 15°, but passing the axis of the flexure it runs close along the north side of the valley, the slate and sandstone (Nos. III and IV) in the gap are nearly perpendicular, and a little further even overturned to 70° south.

"About three and a half miles from the west end, upon the main road up the valley, a pale blue fetid limestone occurs, speckled with yellow spar like the Nippenose "marble." It dips 20° sandy limestone in the creek, two miles further east dips 15° north. The anticlinal becomes more regular near the middle of the valley. In Kleckner's Gap the dip is 30° north.

"The margin of the limestone recedes a little farther from the foot of the mountain east of Kleckner's Gap. At the furnace there is a quarry of massive strata dipping 10° N. 20° E., marking the decline of the anticlinal in that direction."

Crawford Township.

§ 39. This lies north of Green and south of Wayne townships, and is adjacent to Lycoming county along the eastern line.

About one half, or nearly half of Nippenose valley is contained within the limits of this township; the eastern end of the valley being in Lycoming county.

Besides this valley, a portion of the mountainous arch between it and Nittany valley as well as a narrow strip of its enclosing mountains are contained within the township.

The mountainous area composed wholly of the outcropping hard and massive sandrocks of No. IV presents little of economic or geologic interest.

§ 40. *Nippenose valley* is well called from its peculiar shape, the "oval valley. Ten or eleven miles long by three to three and a half in breadth, it has a general elliptical form, the regularity of which is slightly broken by several spurs and ravines.

The geological structure which produced Nippenose and Musquito valleys has already been illustrated by plate III (Chapter 3).

In the report of the First Survey the following data are given to demonstrate the domed shape of the Nittany valley anticlinal in this locality :

"Thus at Anti's gap the dip is 35° N., but at Love's gap only 12° N. 30° W.; at Rattling Run gap 10° S. At Anti's gap the limestone comes quite up to the mountain, into the very side of which the matinal slates (No. III) ascend two thirds its height. But at Shaw's gap the fossiliferous uppermost layers of the Matinal (Trenton No. II) limestone occur 200 yards south of Mr. Shaw's house, dip 5° S., and no limestone can be found any nearer the mountain opposite Love's gap. Limestone has been opened two miles west of Shaw's, and within one mile of that end of the valley.

"At Bixler's tavern in the east end of the valley . . there is a so-called marble quarry which affords a hard solid dark-blue limestone, variegated by thin veins and specks of yellow and sometimes white, spar, and susceptible of a good polish. Its dip is 15° south 20° east. The same rock might be traced through the valley near its centre line. It appears at Epler's tavern, a mile west of Bixler's on its north dip." [See Report on Lycoming county, GG.]

This valley is a complete labyrinth of underground caverns, and water ways, and its surface is prominently marked by deep sink-holes. The stream through which its whole drainage empties into the Susquehanna rises from a subterranean channel but a few thousand feet from the gap.

Ore : The old furnace at the western end of the valley never succeeded in developing any large deposit of ore, and numerous shafts and prospecting drifts have pretty thoroughly demonstrated the non-existence of ore accessible in workable quantity.

The limestone lies very close to the surface throughout the valley, and is easily opened for quarrying. A number of kilns have been built and are in constant operation—a decided improvement upon the open burning plan usually adopted in this region.

Lamar Township.

§ 41. This lies east and north of Greene and north of Logan townships. Its northern limit is defined by the crest of Bald Eagle mountain.

This township contains the eastern end of Nittany valley, and besides this very little else but the mountainous strips of No. IV which enclose the valley.

A very small portion of the red shale valley of Cherry run is included within the southern boundary of the township.

As that portion of Nittany valley in Clinton county is best described as a single whole, its geology will be given after the geographical details of Porter township.

Porter Township.

§ 42. This lies next west of Lamar and north of Logan townships, and is adjacent on its west side to Centre county. Its northern boundary is defined as the crest line of Bald Eagle mountain.

It includes a small strip of Nittany mountain and a portion of Cherry Run valley; the remainder of its area is comprised in the limestone country of Nittany valley.

§ 43. "*Nittany valley* from its head to the end of its southern barrier, Nittany mountain, has a length of thirty-one miles; its breadth varies from five and a half to two miles. Its central region goes by the name of 'The Barrens,' beneath the surface of which lie great accumulations of rich iron ore. This part of the valley is wholly destitute of water. East of Bellefonte two miles the "Barrens" become a ridge, marking the main central anticlinal axis of the valley and attaining at some points of its range considerable prominence, but is everywhere rather an irregular deeply-grooved high ground than a definite ridge. Hard ribs or outcrops of impure limestone make its contour uneven. It falls away and disappears within five miles of the Millhall Gap, beyond which the floor of the valley is gently undulating,

except near the base of the mountains, where the ravines are sharp and deep."

The Nittany valley anticlinal, in Clinton county, lies much nearer the north than the south side of the valley, its north dips being steep,—from 65° to 90°,—its southern dips much more gentle.

At Mill Hall Gap the slates of No. III are completely hidden by *talus* from the hard mountain sandrocks of No. IV. The limestone formation is, however, well exposed, dipping strongly to the north. On approaching Salona this steep dip rapidly changes to an almost horizontal inclination.

From Salona southeastwardly along the road to Logansville the limestone is seldom exposed. Its dip is gentle to the southeast, but on approaching the mountain rapidly increases, and carries the limestone quickly down beneath the slates of No. III.

At Clintondale the ore-ridge ("the Barrens,") is still recognizable. A considerable quantity of pipe-ore of excellent quality was here mined for use in Washington furnace, but most the ore used by this stack was obtained west of the Centre county line, and will be described in the report upon Centre county.

At Washington furnace the dip is 60°, S.40°E.

The ore worked at Salona was mined for use at old Lamar furnace. This stack is now entirely demolished. The mine is about 200 feet long by 75 feet wide, and from 12 to 20 feet deep. Much white limestone, somewhat sandy, is exposed in the excavation.

The following analyses were made by Mr. McCreath from samples taken from this bank. The sample of wash-ore was an average sample obtained by picking at random over a large area. The lump ore analysis was made from a single specimen.

The ore occurs in a ridge somewhat resembling the "Barrens," but evidently lies too far north to be a continuation of that belt of rock.

§ 44. *Analyses of Ore from Salona.*

	No. 1.	*No. 2.*
Sesquioxide of iron,	77.071	74.785
Sesquioxide of manganese,	.030	.030
Sesquioxide of cobalt,	trace.	trace.
Alumina,	.593	2.053
Lime,	.630	.640
Magnesia,	.468	.508
Sulphuric acid,	.087	.097
Phosphoric acid,	.036	.132
Water and carbonaceous matter,	12.650	11.978
Insoluble residue,	8.380	9.780
	99.945	100.003
Metallic iron,	53.950	52.350
Metallic manganese,	.021	.021
Sulphur,	.035	.039
Phosphorus,	.016	.058

No. 1. Kidney or Lump ore.
No. 2. Average sample of Wash ore.

The percentage of phosphorus in No. 1 is surprisingly small; smaller than that given in any one of the twenty-one analyses in Prof. Lesley's Nittany valley report of 1873, and in only two of these latter is the percentage of phosphorus less than that shown by No. 2. The heavy percentage of alumina and silica ("insoluble residue") in No. 2 evidently comes from the clay adhering to the specimens.

Wayne Township.

§ 45. This township lies immediately south of the Susquehanna river, and east from Lock Haven.

Bald Eagle mountain traverses its central portion, and the whole southern part of the township is occupied by the mountain which separates Nittany from Nippenose valley.

This mountain is a broad arch of the massive sandstone of No. IV, produced by a flattening of the Nittany valley anticlinal. It is deeply gorged near the centre by McElhatten's or Mill Run Gap, in which the Lower Silurian slates of the Hudson River group are laid bare. The erosion, however, has not been deep enough to reach the limestones of No. II, so as to make a third valley similar to Nippenose and Musquito valleys.

Mill creek is a stream carrying a considerable volume of water, and is remarkable for the torrents which pour from it during the rainy seasons. The gap, when viewed from the north, is quite pronounced; but the back divide, which must be crossed in going over into Sugar valley, is rather high, so that it is not traveled nearly as much as the easier though more circuitous route by Nittany valley.

The dip near the mouth of the gap is about 35° to the northwest; but farther up the gorge it is impossible to find any reliable exposures, everything being covered under masses of debris of the sandstone and conglomerate which form the mountain summit ledges.

The north slope of Bald Eagle mountain is of quite even contour, diversified only by three indentations, of which McElhatten Gap is the largest. The others are called Love's Gap and Henry's Gap, and are in close proximity to each other. They do not afford any good exposures, and present nothing of geological interest.

The dip along the northern foot of the mountain is quite uniform, varying but little either above or under 40°.

The limestone of No. V (Niagara?), which has been quarried near Lock Haven and Mill Hall Gap, has never been opened in this township. Its outcrop is nearly always covered by a heavy *talus* of loose sandstone, which will embarrass any large workings upon it. A close search, however, might result in the discovery of some places at which it could be profitably opened and quarried.

At Wayne station on the P. & E. Railroad the river makes a large bend which carries it a mile and a half from the mountain. This loop encloses a large flat, a mile or more wide, composed largely of drift. It presents no ex-

posures, but must be underlaid by the limestones of the Lower Helderberg Group (Lewistown limestone, Onondaga and Water Lime shales) No. VI.

§ 46. Pieces of *Fossil ore* are reported to have been found on the mountain, but the bed has never been opened nor is its exact place of outcrop known. Our knowledge of the bed in this vicinity is too meagre to warrant any positive assertions as to its value.

Allison Township.

§ 47. This lies near the centre of the county immediately south and west of Wayne. Its southern end is just touched by Bald Eagle mountain, while is northern border is skirted by the Allegheny mountain foot hills.

Immediately south of Lock Haven, Bald Eagle mountain is gorged by Harvey's Gap; which however does not form a complete breach through the mountain, only piercing its northern half; its southern half is partly eroded; but the divide between the drainage into this gap and the Nittany valley drainage is a sharp one.

The stream flowing through it is utilized as a water supply for the city of Lock Haven. For this purpose two dams have been built; one at the mouth of the gap and one about half way through it, which store up a considerable quantity of water; but during long continued dry seasons, this is exhausted and the city is dependent upon the small flow of the stream alone. The latter sometimes becomes so low that recourse is had to the river, to wells, and to small streams in the neighborhood to supply the deficiency.

The red sandstones and shales of No. V are well exposed for quite a distance at the lower dam; and the red shale and sandstone of the middle member of No. IV is finely exposed at the upper dam. The dip is about 40° north by west at both places. No trace of the fossil ore was observed.

Slickensides.—The silicious sandstones of No. IV exhibit magnificent slickensides. The striae are generally straight and parallel, but I have seen some pieces on which they

were curved. This curvature is generally very slight, but on one block I measured a *deflection of about 60°* which was produced in a curve of *six inch radius*.

The red sandstones and shales of the Clinton group (V) are everywhere found along the north flank of the mountain. They are usually fine grained and micaceous, and frequently covered by casts and impressions of fucoids.

At the foot of the mountain one mile east of Lock Haven are two limestone quarries evidently situated on the same bed that has been worked at Mill Hall, and which probably belongs to No. V, occupying the horizon of the Niagara limestone. Both the quarries are opened on the face of the stone, or parallel to the strike, and "strip" rather than "quarry" the rock.

The following is an average description of the stone exposed:

A. Massive hard blue limestone, . . . 4 feet.
B. Thin bedded, argillaceous, concretionary limestone, ... 5 to 8 feet.
C. Hard massive dark blue limestone, fossiliferous, exposed, ... 6 feet.

Large veins of calcite—sometimes 18 inches thick—traverse the rock along the cleavage planes, and often enclose large water worn sandstone pebbles and more or less triturated fragments of limestone The presence of these pebbles can only be explained in two ways: 1st the river may have washed them into the crevices when flowing at a level 40 or 50 feet above its present elevation, or 2d they may have been triturated and worn into pebbles from angular pieces by subterranean water channels in the limestone. The former theory seems more plausible than the latter.

The dip here ranges from 35° to 45° north by west.

Baird's quarry which is the most easterly of the two is still working, but the other, which is owned by the city of Lock Haven has been idle for some time. Though the lime yielded by this stone is said to be excellent lime for agricultural purposes, it cannot be used advantageously for building, on account of its of rather dark color.

Figure 5 shows a curious crimple which has been pro-

duced by a land slide. The contortion has taken place in the soft thin bedded limestone or calcareous shale marked "B" in the section. The slide has occurred in the direction indicated by the arrow, or down the slope, which nearly coincides with the dip, and has resulted in altogether removing the upper part of stratum A, over the lower part of which the calcareous shale B is completely folded in a peculiarly shaped crimple, without, however, disrupting the latter.

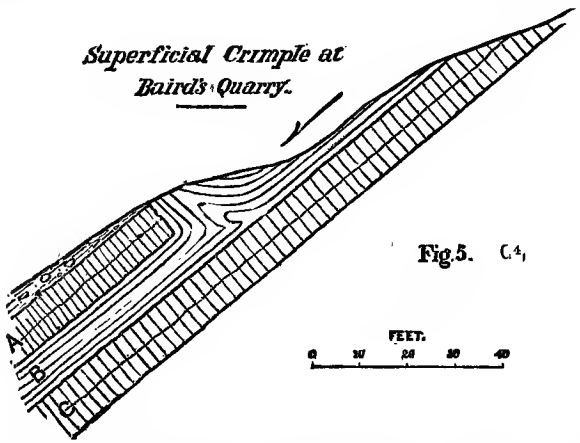


Fig.5. C⁴.

The line of fracture can be followed by quite a decided bench for some distance on each side of the quarry.

In the ridge at Farmington, between Lock Haven and Mill Hall there are several exposures of a limestone which is probably of Lower Helderberg age, but it is possible that it may be the same with that opposite Lock Haven which belongs either to the Marcellus shale or Upper Helderberg group.

No measurement of the thickness of these limestones is reliable, as the truth of any calculation based upon the meagre data furnished by these outcrops, is vitiated by the minor folds traversing Bald Eagle valley from Mill Hall to Pine creek. One of these axes evidently passes through the southern edge of the hill in which the limestone is exposed.

The shales, slates and sandstones of No. VIII,—includ-

ing the Marcellus, Hamilton, Genesee, Portage, and Chemung,—are finely exposed in a series of cuttings along the P. & E. R. R., and have been carefully measured and described in the Lock Haven long section, in Part II. They contain nothing that can be considered of economic value, other than some layers of flaggy building stone in the Hamilton and Chemung. These are generally too ferruginous to withstand weathering in exposed positions, but otherwise are well adapted for foundations, rough out-buildings, etc., being easily gotten out, and readily broken into any required shape.

Bald Eagle Township.

§ 48. This lies west of Allison, is skirted on the south by Bald Eagle mountain, and stretches northwest across the Allegheny escarpment to the dividing ridge north of Tangascootack creek.

The Bald Eagle mountain is fissured, near the centre of the township line, by Fishing creek, which here emerges from Nittany valley and empties its waters into Bald Eagle creek. The gap presents a tolerably good series of exposures, which have been measured and affixed to the Lock Haven measurements in the long section.

The limestone quarry at the mouth of the gap has been open for many years, but was never very largely worked. About 25 feet of hard, massive, fossiliferous limestone is exposed, dipping nearly vertically to the northwest. It is probably of Niagara age, and has been included in No. V, in the section. The stone has been used for agricultural and building purposes, and also as a flux in the old furnace.

§ 49. *Mill Hall Furnace*, originally a charcoal stack, subsequently altered to an anthracite furnace, used the Nittany valley hematites, the "fossil ore," and to some little extent, the "block ore."

The "fossil ore" was opened on the north side of the mountain, west of the Gap, but was only ten or twelve inches thick, and was not worked very largely.

The block ore was opened on the east side of the Gap, and though it is said to be of fair thickness, it was probably rather too silicious for profitable working. The dip here is very steep, varying from 80° to 90°.

In the hill northwest of Mill Hall the limestones of No. VI show an anticlinal roll, with a southeast dip of from 5° to 20°. East of this hill they have been entirely eroded by the combined action of Fishing and Bald Eagle creeks, producing a broad flat basin more than a mile wide. The limestone has been quarried at two places on the west side of this basin, and the stone shipped on the canal, but it is not worked at present.

§ 50. *Oriskany Sandstone.*—Slight traces of this rock are visible along the Bellefonte road in the western part of the township. Evidently thin and friable, it presents no outcrops, and its presence is only shown by local patches of loose sand. At Milesburg, in Centre county, this stratum is finely developed as a hard, massive, conglomeratic sandstone, full of its characteristic fossils, and is well exposed at the R. R. bridge. At Lock Haven it is wanting.

At Beech creek no exposures can be seen. The erosion of this stream through the mountains is quite sharp, but after leaving the Allegheny foot-hills its valley is broad and smooth, and near its junction with Bald Eagle creek, it is remarkably flat and is filled like Bald Eagle valley, with much alluvial drift.

That portion of the township lying north of the Allegheny escarpment includes within its limits most of the Tangascootack coal basin.

Two railroads were built to open up this coal field, but they can now scarcely be found, the rails and even the sleepers having been taken up, the embankments and cuttings now support an undergrowth that is rapidly obliterating all traces of their former existence.

§ 51. The Rock Cabin R. R. ran from the P. & E. R. R. junction, at Farrandsville—where a bridge was built across the river—up the west bank of the river to the Tangascootack, and thence up that stream to the North Fork, where it made a junction with the Eagleton R. R., thence

up the main stream to Rock Cabin. From Rock Cabin branches extended to the Reavilleton and Peacock mines.

§ 52. The Eagleton R. R. ran from its junction with the Rock Cabin R. R. at the North fork, up the mountain by a series of switch-backs to the high land between the north fork and the river, thence it ran northwest to the mines at Eagleton, a total distance of about 12 miles from its distal terminus to the P. and E. lower junction near Queenstown.

Both branches of Tangascootack creek everywhere cut down below the base of No. XII into the Pocono sandstones No. X, but no trace of No. XI, the Mauch Chunk red shale can be found, though at Farrandsville it is represented by about 100 feet of red measures.

The sandstones and conglomerates of No. XII, are partially exposed in numerous precipitous escarpments along the Tangascootack waters, but it is impossible to obtain a very accurate measurement of them. The "Farrandsville switch-back section" (Part II) shows the general character of these measures and can be taken as typical for this locality.

§ 53. The Tangascootack synclinal is a sharp and well marked flexure determining the course of the creek and producing a deflection in Beech creek where that stream crosses it. Its north dips are very sharp, but the south dip (on the north side of the trough) is rather gentle, and is marked by a gradual rise to the north both of the rocks and the general surface level, until the high land near Eagleton is reached. The dip is here reversed by the Furney's run or Eagleton anticlinal.

The following facts, which are mainly historical, bearing upon the coal mines of the township, were obtained from Mr. Nicholas Mann and several other residents who have been familiar with the operations in this field from their commencement. These have been supplemented by such information as could be obtained on the ground, but this is very meagre, as all the works are rapidly falling into decay, and most of the openings are already closed.

§ 54. *The Reavilleton—New York Coal Company's*

bank was opened about 1857 and was worked at intervals until 1870, a large quantity of coal being won in that time.

The bed averages 1′ 6″ and lies 40 feet more or less, above a hard massive sandstone which is a portion of the conglomerate (No. XII). It was found to be too thin for profitable working, but was of good quality. A charcoal furnace was erected on these lands, but after being in blast about nine months, it was obandoned. West of this bank no coal has been opened, though it undoubtedly exists.

§ 55. *The Abram Best bank* was opened 8 or 10 years before the Reavilleton bank and has been worked at intervals ever since, but as the coal has to be teamed to market, comparatively little has been taken out.

§ 56. *The West Branch Coal Company's bank* is situated two miles east of Reavilleton.

It was opened by Mr. Spearing in 1844 and worked by various parties until 1849 when Mr. Edward Piper leased it. He worked it for three years and took out most of the best coal. It was then purchased by the West Branch Company but they never shipped much coal from it, and nothing more has been done up to the present time (1878). It is now again in the hands of Mr. Spearing who is re-opening the entry, and intends to completely exhaust it. It is reported that very little coal remains in the bank that is of marketable quality, except the pillars.

§ 57. The *Rock Cabin banks* were opened in 1848–50 and worked at intervals until 1870, when they were abandoned and not since re-opened. On this property there are three beds all lying within an horizon of 100 to 125 feet. The same arrangement is shown at the Queen's run mines.

These beds are known as the "Four foot" and the "Three foot," the lowest bed not being named, as it is too thin to mine.

The "Four foot" is very sulphury, but the "Three foot" is of good quality and is the bed from which nearly all the coal shipped was mined. There is still a large quantity of available coal upon this property though it may be many years before it can be profitably mined.

§ 58. *The Peacock bank* situated on the Jas. Wilson

lands, west of Rock Cabin was opened in 1865 and though a large quantity of coal was taken out, none of it was shipped, and large dump of it still remains at the bank.

§ 59. The *Eagleton banks* were opened prior to the Rock Cabin mines.

They are situated on very high land, but probably work the same bed as the latter, though the seam is said to be thicker than at Rock Cabin. There is still a large body of untouched coal at these banks.

The openings, having been abandoned for eight or nine years, have all fallen shut, the place has been burned by forest fires, and the settlement is again a wilderness; no one living within several miles of it.

Beech Creek Township.

§ 60. This is a large township lying in the southwestern corner of the country, directly west of Bald Eagle township. It ranges from three to six miles in width and is more than twenty miles long.

The Bald Eagle mountain runs along its southeast line, but furnishes no exposures worth describing. Fragmentary and imperfect exposures of the Lower Helderberg limestones (No. VI) are noticeable along the valley road, and traces of the Oriskany sandstone may be seen at several places on the low ridge north of Bald Eagle valley.

Beech creek forms the southwestern boundary line of the township for a distance of about ten miles, but does not furnish any good exposures. It drains only a very small area in this county. The central part of the township is drained by Big run.

The land lying east of Beech creek and north of the Allegheny escarpment, is yet a wilderness, and the greater part of it is inaccessible except on foot. At one time it was full of lumbering camps, and everywhere contained wood-roads that could be traveled with comparative ease, but these have all passed away and it has relapsed into its former uninhabited state.

There are undoubtedly some good coal lands in this region, but they must be proven by private enterprise, as it is impossible, in the present condition of the country, to obtain any reliable data from surface examinations.

The western end of the Tangascootack Basin extends a short distance into this township, and the Eagleton coal field also overlaps it.

Pine Creek Township.

§ 61. This lies on the eastern edge of the county, adjoining Lycoming county, and directly north of Wayne township.

Pine creek runs for about four miles along its eastern border, and, on the Lycoming county side of the stream, furnishes good exposures of a portion of the limestones of No. VI. The structure is complicated by two overturned anticlinals and an included synclinal, which quadruple the surface outcrop of each bed of limestone, thus greatly widening the valley.

The exposures show (see Fig. 6) Plate V.

Concealed: soft calcareous shale?
Hard massive argillaceous limestone about, 100 feet.
Black calcareous slate and shale about, . 50 feet.
Shaly impure limestone, some good beds, 150′ +
Concealed: beneath anticlinal axis,

No indication of the presence of the Oriskany sandstone was detected.

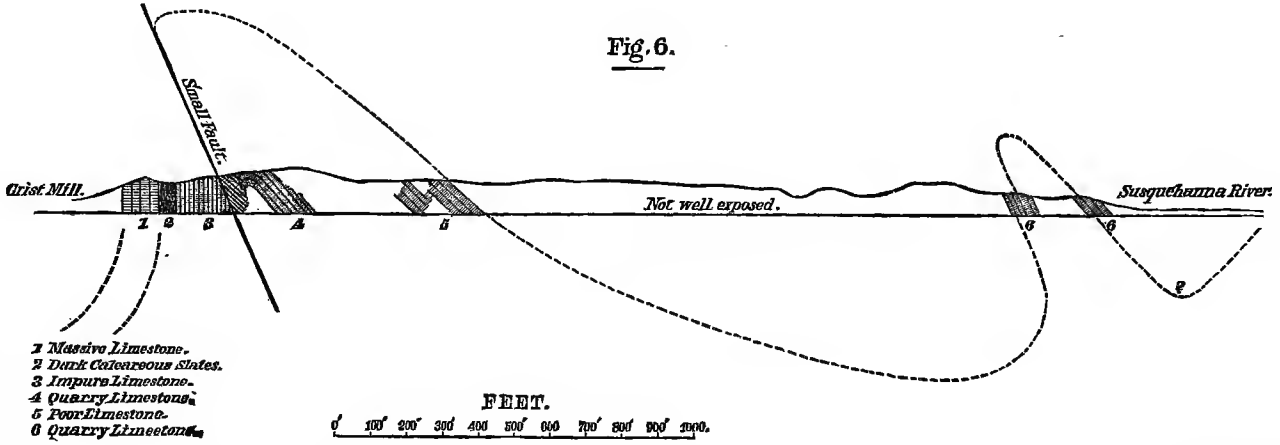
On the west side of the creek the land is very flat and covered with much fluviatile drift. It presents no outcrops or exposures of any kind.

In the northern part of the township, the Catskill is a very prominent formation, producing everywhere the striking red color that is characteristic of the Allegheny mountain outliers. Though often exposed in the small streams and ravines, it presents no good opportunity for measurement, as the exposures are always comparatively small. Frag-

A profile section along the East bank of Pine Creek showing Overturned Anticlinals in the Lower Helderberg Limestones,

by H. Martyn Chance.

Fig. 6.



C.B. Hardon, del.

ments of the fishbed layer can easily be found, but the stratum itself was not found *in situ* in this township.

Dunstable Township.

§ 62. This lies west of Pine Creek township and north of the Susquehanna river, and stretches north to the Allegheny foot-hills of Pocono and Catskill (Nos. X and IX).

It is drained by Big and Little Plum creek. Neither of these streams furnish any noteworthy outcrops.

The limestones exposed along the canal in the low hills near Lockport are rather impure, yet contain some layers that would yield a fair lime for agricultural use.

Though the township contains some good farming land, that along the river bottom being of extraordinary richness, it is barren of interest to the geologist, consisting, as it does, of rounded hills of Devonian rocks, which nowhere are well exposed.

Woodward Township.

§ 63. This lies west of Dunstable township, and north of the Susquehanna river, and extends northwards over the basset edges of the Devonian and Sub-carboniferous rocks, including along its northern edge a portion of the Carboniferous measures.

No trace of the Oriskany sandstone can be detected in this part of Bald Eagle valley, and it seems certain that the rock is absent from this part of the county.

The Chemung and Portage (No. VIII) are not very well exposed in this township, but fine exposures of them are seen in the R. R. cuttings on the west side of the river.

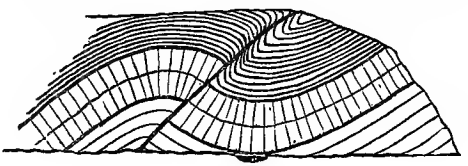
The Catskill and Pocono (Nos. IX and X) afford magnificent outcrops near Queen's run, which were very carefully measured in constructing the Lock Haven long section. (See Part II.)

The Marcellus shale is laid bare by roadside cuts and natural escarpments along the river road, just opposite Lock Haven. It here includes a series of impure beds of limestone, which have been tested unsatisfactorily for the manufacture of lime. They were quarried quite largely and used for ballast in the dam, and have also been used for foundation building.

At first sight it appears as though these beds should be referred to the Corniferous limestone, but they show none of the characteristics of that rock, and are *underlaid* by black slates, lithologically identical with the Marcellus. Were they Corniferous beds, the Oriskany sandstone should be found beneath them, and in the absence of that stratum they should lie upon the Oriskany lime shales or upon the Lower Helderberg limestones. The interposition of 177 feet of black slaty shales at this horizon, and the absence of a corniferous character, fix their proper position as calcareous bands in the Marcellus.

They are again exposed along the canal, a short distance east of Lockport, and also about one mile east of town. At the latter locality a slight downthrow fault is beautifully exposed in a vertical cutting on the tow-path. (See Fig. 7.)

Fig. 7.
Fault in Limestone on the Canal near Lockport.



At Queen's run and Farrandsville a large amount of coal has been mined. This coal field is a continuation eastward of the Tangascootack basin, and contains all the beds found at Rock Cabin. The lower bed is not well developed at either place.

Little coal is now taken out and none is shipped, nor does it seem probable that there will ever be much coal

mined from this basin. Its comparative failure, when compared to the Snow-Shoe district,—which is its probable western extension,—is due to the fact that owing to the shallowness of the basin the "upper bed" of the latter locality is not even caught in its highest ground, and consequently all the coal mined is obtained from the lower beds, which yield a much inferior article.

The trough of the synclinal, which at Farrandsville brings the Conglomerate down to within 350 feet of river level, rises quite rapidly to the northeast, so that on Chatham run the coals have all been removed by erosion, and the Conglomerate is found only in the highest ridges.

The upper bed furnished the best coal mined from this locality. A fine bed of fireclay underlying this coal furnished the Farrandsville brick works with an excellent brick-making article, and this was especially valuable, because it and the coal could be mined together.

The workings were abruptly stopped by a clean-cut fault; a most unusual feature in our bituminous coal fields. When this trouble was encountered it was supposed to be an upthrow fault entirely cutting off all workable coal beyond the headings. If, however, as Mr. Platt has suggested, it be a downthrow, then a large body of coal and fireclay may still be obtained from the other side of the hill. I am informed by Mr. Platt that late excavations at the old workings have shown that the coal abuts against soft shale or slate. This certainly indicates a downthrow fault, for were the irregularity occasioned by an *upthrow*, the hard sandrocks of the Conglomerate, No. XII, would, in all probability, be found in juxtaposition with the coal, whereas a *downthrow* would bring the soft Coal measure shales and slates down into the same horizon.

Fireclay of fair quality was also obtained beneath the lower bed, *i. e.*, the bed immediately overlying the Conglomerate. The middle seam was not worked for clay.

Gallauher Township.

§ 64. This lies on the eastern side of the county, north of Pine Creek, Dunstable and Woodward townships.

The old Coudersport pike, at present entirely abandoned as a highway, forms its eastern boundary line, separating it from Lycoming county.

It is drained by Lick run, Chatham's run, and Queen's run all of which are swift mountain streams and have been of value in furnishing outlets for the large amount of lumber cut in this and adjoining townships.

Nearly all the land of the township is high, with rough steep side hills which render road building very unsatisfactory and quite expensive.

The summits are capped by the Conglomerate, occasionally carrying on its back a thin covering of the Coal measures. This is always so thin that any coal that has been preserved in this way has probably been rendered worthless by weathering beneath insufficient covering.

The "Hog back" ridge three miles north of Mr. Springer's place on the old pike contains two lower coal beds, but their area is limited and the covering is quite shallow.

It seems quite probable that the lowermost of these two beds is an intra-conglomerate coal, as it is occasionally overlaid by a rather course whitish sandstone. These beds may in time become valuable for local use, but as the coal will largely consist of outcrop coal too soft to bear much handling, they can never be looked to for a marketable supply.

They are situated in the Wetham synclinal (probably the same as the Towanda basin), and are not, as has generally been supposed, a continuation northeastwardly of the Queen's run and Farrandsville trough.

Colebrook Township.

§ 65. Lies west of Woodward and northeast of the river.

It is occupied by two high ridges which run nearly north and south, and enclose between them the deep gorge of Lick run.

From the synclinal at Farrandsville the rocks rise very rapidly to the north until the northern edge of the town-

ship is reached; the dip here is reversed by the Eagleton or Furney's run anticlinal.

All the high land of the township is capped by the Conglomerate sandstones. These are subject to sudden variations in this locality, often thinning down in thickness and fining down in coarseness until they are almost as gray and fine-grained as the underlying Pocono (No. X) sandstones. The latter are beautifully exposed along the railroad by a series of cuttings between Queen's run and Farrandsville.

The Mauch Chunk red shale (No. XI) though quite a prominent member of the series at the Farrandsville coal mines, is not found in the northern part of the township.

Three or four beds of iron ore have been discovered in the Pocono (No. X) at Farrandsville, but they are rather thin and of poor quality. Two of these occur in thin bands of red shale near water level at the furnace. They are about twenty feet apart; range from six inches to one foot in thickness, and are of better quality than the other beds.

§ 66. *The Farrandsville Furnace* is one of the most substantially built stacks in the State. Though it was built more than forty years ago and has not been in operation for several years, it looks like a new piece of masonry. The surface of the stone is still clean and sharp, and the pointing is as good as when first put on. The walls of the machine shop are in an equally good state of preservation..

The stack is 54 feet high.

13 feet bosh.

170 horse power blast, with 10 boilers.

The ore used was mainly fossil ore from Montour's ridge in Columbia county; Nittany valley limestone was used for flux and the fuel was coke made from the lower bed of the Farrandsville mines. Prof. Rogers gives the following, as the proportions of charge used in October, 1839:

	Hogshead.	*Tons.*
Coke,	6500	2900
Fossil ore,	3200	1428
Larry creek ore,	3500	1565
Limestone,	4500	2009

The yield was about 50 tons per week.

Grugan Township.

§ 67. The Susquehanna river runs through the centre of this township, splitting it into two nearly equal parts.

Furney's run and Rattlesnake run on the east, and Backer's Mill run on the west side of the river, are its principal streams.

With the exception of the bottom lands of the river flats, there is no good farming land in the township. The plateau soils are quite cold and stiff.

The western edge of the township skirts the Eagleton coal field, but the workable area within its limits is quite small.

On Johnson's run near DeFranceville, a thin and rather poor coal bed has been opened, but the entry is now fallen shut and no measurement of the coal can be obtained. It is evidently the same bed that has been found on Mr. Underwood's place near the pike in Gallauher township. The trough in which it lies has been called the Wetham basin and is probably the equivalent of the Towanda mountain synclinal, though not necessarily continuous with that flexure in an unbroken line.

The exposures along the railroad all show a north dip from the Furney's run (Eagleton) anticlinal to this synclinal at its crossing of the river near the mouth of Rattlesnake run. From the latter locality the strata rise quite rapidly to the north (south dip) until the axis of the Hyner anticlinal is reached, one mile and a half south from Hyner station.

The Hyner axis brings more than two hundred feet of Catskill red rock above water level, but the strong north dip into the Karthaus basin soon carries these rocks down below water level. They probably never re-appear to the northwest, for before reaching their place of outcrop at Emporium they entirely thin away and their horizon is occupied by Chemung shales; but it is possible that the knife edge extension of this rock may be found above water level near Driftwood.

Chapman Township.

§ 68. Until lately this was a township of exceptional size, containing more than 150 square miles, but it has recently been cut into two townships, one of which retains the above name; the other is called Noyes township.

From Renovo to Youngwomanstown (North Point) the Susquehanna river flows but a short distance north of of its southern boundary line. Most of its area therefore lies north of the river.

§ 69. *The Hyner Anticlinal axis* forms the high land along the south line of the township. Its north dip amounts to 200 feet per mile, carrying the Conglomerate from an elevation above ocean of 2000 feet on the crest of the axis, down to about 1150 feet in the centre of the Renovo trough.

The Karthaus-Renovo basin includes all the land of the township, but it contains workable coal beds over but a small area. At Renovo several beds are caught in its deepest portion, but these have not proven valuable; northeast of this locality the axis rises so that in the country between Paddy's run and the Coudersport pike the available coal land is in isolated patches of small extent.

No noteworthy development of coal has been found north of the Renovo trough, for in that direction the rocks constantly rise, keeping the Conglomerate in the hilltops, and producing high land entirely barren of workable coal near the Potter county line. This region is still an uninhabited wilderness; the soil is either tough and cold, or quite stony. It yet contains some few groves of good pine sticks, but as these are being held for better prices, the lumbering interests do not at present furnish much labor or capital to the population.

Glacial markings.

The high lands near the Potter county line should show some traces of *glacial action*, such as groovings, terraces, and moraines; but I have not been able to detect any positive evidence of the former existence of glaciers. The roughness of the country, the comparative haste in making field notes, and the difficulty of making a thorough exam-

ination in a wilderness of undergrowth, may have contributed to this negative result. It is possible, however, that the action of the Potter county glaciers did not extend over this area, and that their markings will only be found north of the county line.

Noyes Township.

§ 70. This has been recently created by bisecting Chapman township. Being formed from the western part of that township, it lies southwest of the present area known as Chapman township. Beech creek township bounds it on the south, and Leidy township adjoins its northern line.

The highlands formed by the Hyner anticlinal occupy most of its area and present nothing of interest. This ridge rises as an individual mountain far above the average level of the Allegheny mountains. It skirts the river from Karthaus to Hyner's run. A short distance below the latter place the river cuts across the flexure in a sharp steep cut, with side slopes of from 25° to 40°,—locally precipitous,—the mountains on either side rising to a height of from 1200 to 1400 feet above river level.

From the river eastward it is still a well marked ridge, always capped by the sandstones of No. XII. It becomes less prominent near the Lycoming county line, but the run of its vertebral axis can readily be traced by the topographical features from one side of the county to the other.

Though there is occasionally a thin band of the Mauch Chunk red shale (No. XI) underlying the Conglomerate, it is seldom exposed, and indeed is often wanting, for in many places where the exposures are good, the Pocono sandstones (No. X) can be seen immediately beneath No. XII.

The Pocono sandstones are often finely exposed in abrupt, precipitous escarpments along the Susquehanna river. These outcrops often occur in benches or steps, giv-

ing to the mountain, when viewed from a distance, a banded or ribbed appearance.

The river bottoms furnish some good land, but its area is very small.

Karthaus Coal Company's tract.

§ 71. This lies in Noyes and partly in Chapman townships. The company expended a large amount in opening up the property, but after operations had been continued for some time it was found that the coal beds were too inconstant in thickness and quality for profitable mining. Mr. C. A. Ashburner and Mr. C. E. Billin made a special survey of this tract in 1875. Their report will be found in chapter V of this volume.

Mr. Ashburner's vertical sections show a number of beds, all of which are more or less valuable, some being of quite good quality; but a series of test holes, drilled by the advice of Prof. Lesley, has shown that they do not extend as such through the centre of the tract.

This is a feature that should always be carefully investigated before opening for actual mining, any coal field. The "show" at the mouth of an entry will, in a majority of cases, be found to represent the maximum thickness of the bed. This is especially true of the lower coals, *i. e.*, those immediately over the Conglomerate and the Intra-conglomerate beds. If a bed of coal is quite variable in thickness, changing frequently from three or four feet to one foot or less: it is evident that, other things being equal, the smut or blossom of the bed will be most prominent, and consequently most easily detected, at those points where the bed has a maximum size. At these places prospecting entries will be driven in; perhaps several will be opened on the same seam, all showing a bed of about the same thickness. In such a case the conclusion that the bed maintains the size seen at the openings over all of the available area, is too often and generally too hastily drawn. The Renovo coal tract is an excellent example of such a phenomenon. The principal features presented by it are described in Mr. Ashburner's report.

Westport Coal lands.

§ 72. These lie between Kettle creek and Cook's run, on the west side of Kettle creek; and on the east side of the creek, between it and Shintown run.

The openings made on the east side of the creek have fallen shut, and very little can be seen; but a seam of coal 4′ 3″ thick, good and hard, is reported as having been opened by Mr. Hazzard.

On the west side of the creek, and on the hillside facing Little Cook's run, Messrs. Merriman and Munson have opened up a fine seam of bright black coal, five feet thick.

An entry has been driven in upon the coal for a distance of about 200 yards, and a cross-heading driven at a right angle to it for a distance of 30 yards, more or less. In no place in this opening does the seam measure less than 4′ 7½″, and in some places it has a thickness of 5′ 0″.

An average measurement of the bed shows (Fig. 8):

Slate roof, hard and firm, ...	—
Coal, ...	6″ to 8″
Bone, not persistent, . . .	2″ to 0″
Coal, ...	1′ 8″ to 2′ 2″
Slate parting, ...	1½″ to 1″
Coal, ...	1′ 9″ to 2′ 0″
Hard rock floor, ...	—

8.

At the drift mouth the coal measured the thickness shown by Fig. 9, and at the face of the cross-heading the second measurement was made (Fig. 10):

Slate roof.	
Coal, .	8″
Bone, .	1″
Coal, .	2′ 1″
Slate, .	1″
Coal, .	1′ 11″

9

Slate roof.	
Coal, .	8 ″
Bone, .	1½″
Coal, .	2′ 0 ″
Slate, .	1 ″
Coal, .	1′ 9 ″

10.

Another opening on the same bed was made a few years ago in the bluff overlooking "Short bend," in Kettle creek. This was driven in on outcrop coal, of which about 6 feet, was found. It is about three fourths of a mile in an air-

line from the new drift, and ten feet lower than that opening. The new drift is 645 and the old opening 635 feet by barometer above railroad level at Westport.

The seam has from 90 to 130 feet of cover; enough to insure hard coal were the bed like most our bituminous coal seams, but its structure is peculiar, the cleavage planes being very numerous and very close together causing the coal to crumble up into very fine stuff before it has been subjected to rough handling. Hence the great importance of proving its coking qualities.

An analysis made by Mr. McCreath from an average sample obtained by taking specimens from every inch of the bed from top to bottom, (omitting only the one inch binder of slate found near the middle of the bed) is appended. The slate band was omitted because it can readily be cleaned from the coal:

Water at 225°,	.760
Volatile matter,	21.465
Fixed carbon,	66.069
Sulphur,	2.631
Ash, (grey, pink tinge strong,)	9.075
	100.000
Coke per cent.,	77.775

Two specimens of coke, one made from slack coal, the other from picked lumps, and coked in open hives at the drift mouth in the woods, yielded on analysis (McCreath):

	No. 1.	*No. 2.*
Water at 225°,	1.000	.325
Volatile matter,	1.467	.760
Fixed carbon,	91.405	86.090
Sulphur,	2.038	1.775
Ash,	4.090	11.050
	100.000	100.000
Color of ash:	reddish-gray.	reddish-gray.

No. 1. Coke from lump coal.

No. 2. Coke from slack coal.

The quality of the coke could certainly be greatly benefited by a previous crushing and washing of the coal, but it is impossible to estimate how much of the sulphur could thus be eliminated.

The coke is coherent, moderately porous, with metallic ring and lustre, but from the manner of coking is necessarily more or less dirty.

A shaft 25 feet deep was sunk to a coal seam, thought to be the same with the one above described which reached only outcrop coal. This was located four miles N. W. from the drift and two miles from the old Butler road. Another shaft 3 miles from the drift and 40 feet deep was sunk to a bed reported 5 feet thick and thought to be on the same seam.

In the present state of development of this coal property it is impossible to estimate the area underlaid by this coal seam. From rough guesses made in walking over the ground I have summed up about four hundred acres or more that is high enough to contain the bed with from 60 to 120 feet of cover. Whether the seam will maintain its thickness over all this area yet remains to be determined, and this can only be demonstrated by actual workings on the bed, or by prospecting bore-holes.

A section of the Coal measures capping the Conglomerate at the drift is given in Fig. 11. It was compiled from surface indications alone, as no actual exposures of the rocks can be found in this immediate vicinity.

Westport Section.

Shales and slate with some few sandy layers in summits, . . .	130′	
Coal, opened, ...	5′	
Concealed, shale and slate, ?	15′	55′
Sandstone, "say,"	15′	
Concealed, shale and slate, .	25′	
Coal? prominent terrace with marsh, ...		
Concealed, soft slate and shale, .	45′	
Coal? reported, (no indications.)		
Sandstone and conglomerate, . .	—	

11

5 G⁴.

The outcrop of the five foot seam always makes a prominent bench by which its horizon is easily determined; the "15 foot" sand-rock occurring a short distance below it and the conglomerate and sandstones forming a bold bench and rocky terrace 100 feet beneath the bed are additional and valuable guides in prospecting for this coal seam.

Fifty-five feet more or less beneath this seam a prominent bench, marked (when on the right side of the hill) by swampy ground, water seeps, etc., in which a bed of fireclay may be detected, strongly indicates the probable existence of a coal seam of workable thickness. It may yield a coal of sufficient hardness to bear transportation. But until the bed is opened, it is impossible to tell what it will furnish.

The coal noted with an interrogation immediately above the Conglomerate (No. XII) was not seen nor was any indication of such a bed observed. Its place is indicated in the section from a legendary rumor that a seam has been found at about 80 or 90 feet beneath the five foot bed.

Leidy Township.

§ 73. This lies in the northwestern corner of the county. It is drained by Kettle creek, which flows in a tortuous channel from its northern to its southern boundary line.

The township is yet a wilderness, supporting a very small population, nearly all of which is concentrated in the val ley of Kettle creek.

This latter is a large stream and has furnished a good outlet for the lumber, not only from this township but from a large portion of Potter county. During high water it is large enough to run half rafts.

In going from Westport northward to the Potter county line the same topographical and geological features are noticed that are so prominent on the Sinnemahoning above Keating. Near the mouth of the creek the valley is very sharp and narrow with very high side hills. Farther up the stream the gorge broadens, the hillsides are less harsh,

occasional flats are seen at the loops, and more or less cleared land on the lower parts of the side hills.

The red shale and sandstone of the Lower Pocono becomes more and more prominent as it is carried higher above water level by the Driftwood anticlinal which apparently crosses the stream near Ox Bow bend.

§ 74. *The Ox Bow well*, a short distance above the bend, was drilled for oil [in the summer of 1878] to a depth of nearly 1800 feet. One or two slight oil shows were obtained, and gas sufficient to fire the boiler flowed from the well during the last 800 feet of drilling. This well started at about the same horizon (geologically) as the Hyner well. No record of the drillings was kept, and no trustworthy description of the strata passed through can now be obtained. Mr. James David, of Lock Haven, states that there was but little red rock found in the well. "Not nearly so much as we had in the Hyner well." This is what should have been anticipated, from the thinning away of the Catskill red rocks in a northwesterly direction.

East Keating Township.

§ 75. This has been formed from a part of Grove, and a small portion of Keating township, and lies next east from Cameron county.

The Sinnemahoning river passes through it near its southwestern border, but it contains no other stream of any importance.

Its southeastern corner laps over into the centre of the Karthaus synclinal, but the hills are not high enough to take in any valuable coals.

At Wistar, between Keating and Round Island, the Wistar Coal Company have expended a large sum in attempting to mine from one of the lower beds. Several reasons are currently given, explaining why the undertaking was unsuccessful, but the true cause will undoubtedly be found

to be the poor quality, thin covering, and unreliability of the coals opened.

Several years ago, a bed of coal was opened in the mountain between the forks of Cook's run, but was probably one of the lower beds, and did not encourage any further operations.

West Keating Township.

§ 76. This lies altogether west from the remainder of the county. It is bounded on the northwest by Cameron county, on the west by Clearfield, and on the southeast the Susquehanna river separates it from Centre county.

The Karthaus synclinal trough traverses its whole length, bringing down into the hill-tops along its central line, four of the regular beds of the Lower Productive Coal measures. The land along this axis is partly cleared, and some of it is very fair farming land, but north and south of this area cultivated land is unknown.

The First anticlinal axis of the First Survey should be found along the northern edge of the township, but this has almost if not altogether disappeared, or is present simply as a very minor roll on the south side of the Second axis. No trace of it can be detected on the Sinnemahoning river. The *Second Coal basin* is therefore absent northeast of Clearfield county. This fact accounts for the great width of the Karthaus basin in Keating, Leidy, Noyes, and Chapman townships.

In this township the width of the deeper part of the basin, in which workable coal is caught, varies from one and a half to two and a half miles, but in consequence of the local erosion of small streams, the available coal area is comparatively small.

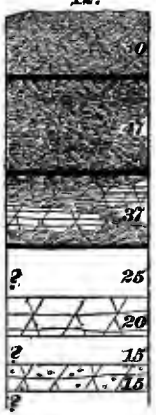
Many openings have been made on all the beds, but as most of them have long since fallen shut, the following descriptions are necessarily lacking in details. Little coal has been mined from any of the banks, but this is owing to their distance from the railroad.

At Rauch's, on the John S. Furst farm, near the upper branch of Three Runs, three beds have been opened. The lowest opening is entirely closed The coal opened by the middle bank may still be seen, though the entry is in miserable condition. It is of fair quality.

The upper bed was opened by a shaft 30 feet deep, which was not accessible when visited. A barometric measurement, checked for the details by hand leveling, gave the section in Figure 12.

12.

	Shale, ...	30′
*Elv. 715′	Coal—upper bed, .	2½ to 3′
	Sandy and slaty shale,	47′
Elv. 665′	Coal—middle bed, .	3′
	Shale and shaly SS.,	37′
Elv. 625′	Coal—lower bed . .	1′ 6″
	Concealed, . . .	25′
Conglomerate measures	Sandstone, hard, . .	20′
	Concealed, . . .	15′
	Conglomerate and conglomerate SS., iron-stained,—exposed,	15′



Below the "fifteen-foot" Conglomerate, the measures are quite sandy and evidently belong to the Conglomerate series, but no good exposure could be found, and their junction with the Pocono sandstones was not determined.

The middle bed of the above section is probably a very fair coal, but the bank was full of water when visited and only the soft outcrop coal could be examined. It dips towards the south.

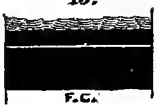
On the Patrick Showden farm four beds are reported as having been discovered, but only one of them—the uppermost—has been opened. This bed lies near the hilltop and does not cover a very large area. It contains many sulphur bands, yields a large percentage of ash, and is a very inferior coal.

A measurement of the bed gave the structure shown in Figure 13:

* Elevations above Keating Station, which is 718′ above ocean.

Grey shale roof,	—
Coal,	8″
Slate,	2″
Coal,	2′ 2″
Fire clay floor,	—

13.

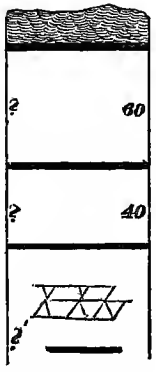


The lowest bed is overlaid by a hard massive sandstone and probably is an intra-conglomerate bed.

The section given in Figure 14 shows approximately the relative positions of the beds reported upon this farm. Their outcrops were pointed out to me by Mr. Showden.

Coal (opened,)	3′
Concealed,	60′
Coal (at house,)	3′
Concealed,	40′
Coal smut,	—
Concealed—contains hard massive sandstone,	?
Coal (reported,)	—

14.



The second bed has been laid bare in digging near the house, but I could see nothing but the springs that come out at its horizon.

On John Rohen's farm a bank has been opened at an elevation of 710 feet above Keating station. The coal is apparently of good quality and measures as in Fig. 15:

Shale roof,	—
Coal,	6″
Slaty coal,	6″
Coal (seen,)	2′ 0″

15.

As the bottom of the coal was not visible the lower bench may be considerably thicker than 2′ 0″. It has a fireclay floor.

Another bank has been opened on this farm at an elevation of 775 feet above Keating, but the entry has long since

fallen shut. The bed is reported to be about four feet thick. These beds are probably the same with the two uppermost beds on the Showden place.

At the George Rohen bank a coal of superior quality has been opened. It is a very black, lustrous, cuboidal coal, remarkably free from sulphur, and is said to leave very little ash. It has been used for blacksmithing to which purpose it is admirably adapted, as it has only thirty feet of cover. Its available area is not large. A measurement of the bed gave (Fig. 16):

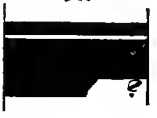
16.

Sandy shale roof, ... —
Rather poor laminated coal, 1′ 2″
Coal—good (seen,) . . . . 1′ 10″ (2′ 10 ?

The seam is said to be 4 feet thick but only three feet of the bed was visible above water line in the bank. It lies at an elevation of 820 feet above Keating and is probably a higher bed (geologically) than any of the previously described coals.

The "New Garden" bank is opened in the same hill about 60 (?) feet beneath the Rohen bank. It is commonly reported to be six feet thick but I do not think it will be found to yield much more than four feet. The only measurement I was able to make, gave (Fig. 17):

17.



Slate roof, ... —
Coal, ... 8″
Bone, ... 2″
Coal (seen,) . . . . . 2′ 0″
Coal (reported, ... 1′ 0″

Its elevation is 760 feet above Keating, making it 60 feet lower than the Geo. Rohen bank, but as the coal dips very sharply into the hill towards the Rohen opening, the actual interval between the two beds is probably 80 feet.

The New Garden bank was opened *with the dip*, and operations were soon stopped by the large amount of water that accumulated in the entry. To mine this bed successfully, it should be opened on the same side of the hill as the Rohen bank. It seems probable that the Rohen coal is the same with the Karthaus middle seam.

In the reports of the First Survey, mention is made of a bed of limestone underlying the New Garden coal. I have not been able to find any trace of limestone in the township, nor have I even heard rumors of the existence of such a bed. It seems certain that either the hill-tops are too low to catch the Karthaus limestone, or that stratum has disappeared. It is undoubtedly absent at Renovo.

Chapter V.

Renovo Coal Basin.

BY CHAS. A. ASHBURNER.

§ 77. That part of Clinton county west of the Susquehanna river and Youngwomanstown creek lies in the Karthaus or Renovo synclinal. It is the continuation of the Second (Johnstown) sub-basin of the First Bituminous coal basin of the south-western counties; the prolongation of the same to the north-east is known as the Blossburg or Third* basin.

The high land lying between Drury and Shintown runs has been designated for a number of years by the special name of the Renovo Coal Basin. Recently the name has been applied to the entire synclinal within the limits of Clinton county, and has become synonymous with the name Karthaus basin to the south-west and Blossburg basin to the north-east.

When the accompanying topographical map, Plate V, (embracing the area specially known as the Renovo coal tract†) was made, prospecting had been done, and four distinct and well defined coal beds were then opened. Extensive *improvements* were made to develop the tract on a large scale, and not a small quantity of coal had been mined and shipped to market; but operations were commenced on the wrong side of the property,‡ against the dip, and the

*Name adopted by Mr. Hodge of the First Survey, see page 33.

† This map and the facts contained in the report are the result of a survey made conjointly by Mr. Chas. E. Billin and myself in the early part of September, 1875. The examination was planned by Mr. Joseph Lesley, Secretary of the Pennsylvania railroad, and it was due largely to his judgment and advice that the survey was both expeditious and thorough. (C. A. A.)

‡ The mines should have been opened on Shintown run instead of Drury run and nearer the center of the basin. As may be seen from the elevations of the coal drifts, the dip of the strata is to the north-west from Drury to Shintown run.

coal beds proved to be too thin and too impure to be either profitably mined or economically burned as a fuel.

The property was covered with transit lines, and the terraces formed by the strata lying between the coal beds were traced from the Drury run openings around the face of the mountain along the west branch of the Susquehanna river, and then to the north-west along Shintown run to the center of the basin. No very great difficulty was experienced in identifying the several coal beds opened on the east and west side of the property, and thus the following columnar section of the coal measures was constructed:

1.	Interval, concealed,	15′
2.	*Coal* No. 5, *Dagus? Kittanning Lower*,	4′
3.	Fireclay,	
4.	Interval, concealed,	92′
5.	*Coal* No. 4,	3′ 2″
6.	Fireclay containing kidney ore,	10′
7.	Shale and shaly sandstone,	15′
8.	Coarse grained sandstone,	26′
9.	Interval, concealed,	4′
10.	*Coal* No. 3,	4′
11.	Interval, concealed,	26′
12.	Gray sandstone,	10′
13.	*Coal* No. 2,	3′ 2″
14.	Hard gray sandstone, and shale,	33′
15.	*Coal* No. 1,	1′
16.	Conglomerate,	25′+

§ 78. The highest geological strata are to be found in the center of the basin, immediately above drift 8.

Coal No. 5 was opened by Mr. E. E. Hazard of New York, about 1868, at drift 8. This adit was driven on the bed for 200 feet, north 55° east. An average thickness of the bed is about 3 feet.

A specimen of the coal was sent to Mr. A. S. McCreath for analysis, the result of the examination was as follows:

Water,	.850
Volatile matter,	25.800

Fixed carbon,	56.605
Sulphur,	7.245
Ash,	9.500
	100.000
Coke per cent.,	73.35
Color of ash,	strong pink.

The coal contains a very large amount of pyrites in thin seams running through the entire bed.

The elevation of the drift is 1516 feet* above tide, and 60 acres of the basin are covered by the bed.

This coal is without doubt the representative of the *Dagus coal* in McKean and Elk counties, and of the *Kittanning Lower coal* along the Allegheny river.

The interval of 92 feet, Nos. 3 and 4 of the section, is almost entirely concealed. It seems to be composed principally of shales and shaly sandstone.

The horizon of the *Ferriferous limestone*† is about the center of this interval. Limestone has been variously reported to exist on this property, but I have failed to find any limestone at Renovo and in Cameron county, to the west, to represent the ferriferous.

Coal No. 4 has been opened at drift 6, on Drury run, and drifts 7 and 9 (Shintown opening), on Shintown run. An average thickness of the coal over the property is 3 feet 2 inches. At Shintown opening (drift 9), which is on the west bank of Shintown run, about half a mile north of the axis, the bed measured only 2 feet. An analysis of the coal from this opening showed:

Water,	1.380
Volatile matter,	23.300
Fixed carbon,	55.033
Sulphur,	1.043
Ash,	19.244
	100.000
Coke, per cent.,	75.32

*On Plate V the elevation of the drift is stated as 1316′, it should be 1516′.

† Clermont limestone, Report R.

Color of ash, ... reddish gray.

The coal is very slaty.

At drift 6 the section was:

1.	Slate and bony coal, ...	2′ 6″
2.	Smut, ...	9″
3.	Coal, ...	1′ 8″
4.	Fireclay, ...	—

The coal presented a better appearance here than at the Shintown opening. The section was measured very near the outcrop.

At drift 7 the bed was not seen.

The area covered by this bed is 850 acres. The bottom of the bed at drift 6 is 1488 feet above tide; at drift 7, 1423 feet, and at drift 9, 1536 feet.

This bed is the equivalent of the *Clermont* coal in McKean and of the *Clarion* coal in Clarion county.

§ 79. Strata 6 to 16 (inclusive) of the section are the representatives of the POTTSVILLE CONGLOMERATE No. XII. The group is sub-divided as it is in Cameron, Elk and McKean counties;* the representatives of the individual members in these western counties are indicated in the following comparison:

Strata 6 to 9, (inclusive)=Johnson run sandstone.	XII.
Coal bed No. 3=Alton Upper coal.	
Strata 11 and 12=Alton shales and sandstone.	
Coal bed No. 2=Alton Lower coal.	
Stratum 14=Kinzua creek sandstone.	
Coal bed No. 1=Upper Marshburg coal.	
Stratum 16=Olean Conglomerate.	

The "*25-foot rock*," at the base of the section is the bottom of the POTTSVILLE CONGLOMERATE No. XII. A water well was sunk through this rock and into the underlying Mauch Chunk red shale, No. XI, at the head of the incline plane on Drury run.

Coal No. 3 (*Alton Upper coal*) has been opened at drifts

* See Report R.

Nos. 4 and 5. The elevation of drift 4 is 1486 feet, and the section of the bed is as follows:

1. Coal, ... 2′
2. Slate, ... 1′
3. Coal, ... 8″

At drift 5 the coal was said to have the same thickness as at drift 4. The elevation of the bed at drift 5 is 1468 feet. The area covered by this bed is about 1790 acres.

According to a statement made by Mr. L. R. Morton, superintendent of the property at the time the examination was made, the best coal ever found was that mined from the upper part of this bed.

Coal No. 2 (*Alton Lower coal*) has been opened at drifts 1, 2, 3, and 10. At drifts 1 and 3 a section of the bed was not obtained. At drift 2 the following measurements were taken:

1. Coal, ... 1′ 9″
2. Slate, ... 3″
3. Coal, ... 9″
4. Slate (bony), ... 2″
5. Coal, ... 3″
6. Fireclay, very hard, ... —

In some localities a small coal seam 10″ to 14″ thick is found 7 to 8 feet underneath this coal bed.

At drift 10 the coal measured 34″ thick.

The elevations of the openings on bed No. 2 are: Drift 1=1383′; drift 2=1393′; drift 3=1450′; drift 10=1400′. The area of the bed is about 2140 acres.

Coal No. 1 was passed through in the water well near the head of the incline. The section at the well is as follows:

1. Dark-gray sandstone, ... 8′
2. *Coal* No. 1, ... 1′
3. Conglomerate (OLEAN), ... 25′
4. Red shale (Mauch Chunk, No. XI), ... 23′

§ 80. After the survey was completed, and to test my conclusions, the Karthaus Coal and Lumber Co. drilled a hole by the Diamond drill, near drift 7, to a depth of 207

feet. The record was kept with great care, and reported to me as follows:

1.	Earth,	5′	0″	to 5′	0″
2.	Fine sandstone,	9′	0″	to 14′	0″
3.	"	24′	9″	to 38′	9″
4.	Black slate,	9′	10″	to 48′	7″
5.	*Coal and slate*, No. 4,		7½″	to 49′	2″
6.	Dark slate,	17′	9″	to 66′	11″
7.	Fine sandstone,	4′	2′	to 71′	1″
8.	Slate and dirt,	3′	2″	to 74′	3″
9.	Fireclay,	20′	9″	to 95′	0″
10.	Red fireclay,		6″	to 95′	6″
11.	Light and red clay mixed,	2′	0″	to 97′	6″
12.	Red clay,	4′	8″	to 102′	2″
13.	Fine sandstone,	5′	10″	to 108′	0″
14.	Red clay marking horizon of *coal* No. 3,	3′	2″	to 111′	2″
15.	Fine sandstone,	2′	9″	to 113′	11″
16.	Red clay,		2″	to 114′	1″
17.	Fine sandstone,	3′	7″	to 117	8″
18.	Red clay,		3″	to 117′	11″
19.	Fine sandstone,	1′	10″	to 119′	9″
20.	Red clay,	3′	10″	to 123′	7″
21.	Fine sandstone,	7′	7½″	to 131′	2″
22.	Red clay,	4′	8½″	to 135′	11″
23.	Fine sandstone,	8′	9″	to 144	8″
24.	Black slate representing *coal* No. 2,		10½″	to 145′	7″
25.	Light clay,		10″	to 146′	5″
26.	Red clay,		8½″	to 147′	1″
27.	" and sandstone,		8″	to 147′	9″
28.	Fine sandstone,	4′	6″	to 152′	3″
29.	Red and yellow clay,	5′	0″	to 157′	3″
30.	Light clay,	1′	3″	to 158′	6″
31.	Red and yellow clay,	3′	11″	to 162′	5″
32.	Light clay,	1′	7½″	to 164′	1″
33.	Fine sandstone,	28½′	1½″	to 192′	2″
34.	Hard gray sandstone,	14′	10½″	to 207′	1″

The comparison which I have suggested between this record and the general section will be found, upon close study, to confirm the description and rock thickness of the section. The boring was stopped at the base of the conglomerate.

PART SECOND.

A SPECIAL SURVEY OF THE

SUB-CARBONIFEROUS,

FROM THE ALLEGHENY MOUNTAINS

TO THE

CLARION-VENANGO OIL DISTRICT

ALONG THE SUSQUEHANNA.

CHAPTER I.

Introduction.

§ 81. The Palæozoic column of Pennsylvania rocks has long been thoroughly known in Pennsylvania, and its individual members identified with and in some cases named from the corresponding rocks in the State of New York. But while the Coal measures proper were studied and their beds classified and arranged, and the Subcarboniferous rocks of the oil regions identified with their homologous formations in Ohio, the true relationships of the Subcarboniferous in Western and Eastern Pennsylvania were not satisfactorily determined.

It is through the northwestern counties alone that the subcarboniferous rocks of Eastern Pennsylvania and New York can be actually traced by stratigraphical observations to their connection with rocks of the same age in Western Pennsylvania and Ohio; and this correlation could hardly have been made prior to the date at which the material for

this report was collected [1878], for it could not have preceded the work done in the Coal measures proper.

The Bituminous coal fields have now been very carefully studied and nearly their whole area has been described in the reports already printed, so that from the face of the Allegheny mountains to the Ohio line there are few undetermined horizons. As a whole, the geologic scheme of these measures may be considered almost if not quite perfected.

Although our knowledge of the series underlying the Brookville coal is still somewhat defective, the results obtained by Mr. Carll in the Oil regions, Mr. Ashburner in McKean county, and Prof. White and myself on the Beaver river, together with some additional facts given in this volume, go far towards placing the stratigraphy of the Conglomerate series in a true light.

The structural geology of the Oil region has been thoroughly discussed by Mr. J. F. Carll in reports I, I.I, I.I.I, in which a local nomenclature is adopted. By means of numerous well records, surface sections, and tide water elevations of quarries, coal beds, etc., he has clearly traced out the connection between the Oil rocks and the Ohio sub-carboniferous rocks; but his connections eastward with the outcrops along the Allegheny escarpment were broken by the unexplored condition of the Sinnemahoning region.

Throughout this area—which is one furnishing poor exposures—many local examinations have been made, but being disconnected these have been productive rather of confusion and often of serious error.

§ 82. In some of the northern counties the red transition layers called Lower Pocono in this report seem to have been mistaken by the geologists of the First Survey for the Mauch Chunk red shale No. XI. In some localities they were merged in the Catskill, No. IX.

This latter error, as I hold it to be, and will endeavor in this report to prove, is easily made; for, just when the Red Catskill thins down to a knife edge and disappears the lower part of the Pocono assumes a characteristic red hue.

The fact that a heavy red rock is often found overlying the Venango oil-sand-group has led to the inference (on

the assumption that the red was Red Catskill) that the oil group is of Chemung age. *Red rocks are, however, found between the oil sands as often as over them.*

But it is to a misapplication of the theory of a universal thinning of these formations to the west that most of these discrepancies are due. This theory, *per se*, and in its broadest sense, is undoubtedly true; but it has been assumed that if the formations thin in a westwardly direction the diminution in the thickness of each stratum must be approximately proportional to its relative thickness. That this is at variance with facts is shown by the sections and measurements given in Chapter X further on.

§ 83. I think that the facts presented in this report will show that the Mauch Chunk red shale, No. XI, and the Red Catskill, No. IX, diminish in thickness rapidly from the Allegheny mountains westward, so that in a few miles the latter entirely disappears; whereas the Pocono (Vespertine No. X) thins gradually for a few miles, then maintains a nearly constant thickness for ninety miles, when it rapidly looses its lower half by a rise in the Chemung floor at the oil-sand shore-line, and again stretches away to the west with a nearly constant thickness for one hundred miles or more.* Under the assumption that each formation feathered out gradually to the west, it became necessary to find representatives for all the Pennsylvania numbers in the oil regions and throughout Ohio, but attempts to do this seem to have resulted in perplexing discrepancies.

Among other causes productive of erroneous identifications in the northwestern counties insufficient palæontological data may be mentioned. The lines of demarkation between Subcarboniferous and Catskill and between Catskill and Chemung fossil horizons are not uniformly drawn by palæontologists, and as—from the conditions essential to the growth of shell fish—it seems certain that there must

*This conclusion of mine has been foreshadowed by Dr. J. S. Newberry, p. 23, Vol. III, Geol. of Ohio, where he says: "That the *Vespertine* [Pocono] connects through this gap with the *Waverly of Ohio*, is indicated by the Waverly fossils found continuously from McKean county to the Ohio line; but that the *Umbral* [No. XI] and *Catskill* [No. IX] do not reach Ohio seems demonstrable."

(at some points) be an overlapping of the fossil fauna of one formation into that above it, the structuralist cannot accept unquestioningly an identification supported by palæontological evidence alone.

This report has for its basis *a series of measured sections* made at short intervals along the line of the Philadelphia and Erie railroad from Queen's Run in Clinton county to Ridgeway in Elk county. These have been supplemented by several records of test wells, drilled for oil; by a few surface sections furnished by Mr. C. A. Ashburner; and by oil well records from Report I.I.*

* Prior to making any examinations on the Susquehanna river, I was directed by the State Geologist to study the exposures of Devonian and Subcarboniferous rocks in the Allegheny mountain at Altoona and Snow Shoe, and to collate any facts thus obtained, with my reconnaisance sections on the Lehigh and Schuylkill rivers, where the typical developement of No. X, No. XI, and No. XII occurs. The data thus obtained, together with measurements from the reports of the First Survey, and sections from other sources, have been incorporated in this report to illustrate the structural views advanced in chapter VIII.

Chapter II.

Stratigraphical Description of the Conglomerate and Sub-Conglomerate Rocks.

§ 84. The Sub-conglomerate formations are best developed in and around the anthracite coal fields, where they sharply accentuate the series of the Pennsylvania numbers by the great red masses of No. IX and No. XI which measure respectively 5000 and 3000 feet. Between their exposures on the Susquehanna river in Northumberland and Dauphin counties and their outcrops along the face of the Allegheny mountains there intervenes a strip of country, fifty miles broad, from which they have been eroded. But they can be easily followed from Luzerne county through Lycoming and Clinton counties; so that at Lock Haven, Snow-Shoe, Altoona and Broad Top sections have been obtained showing most of the rocks from No. VIII up to No. XIII.

The Mauch Chunk red shale No. XI is thus shown to vary from 3000 feet at Mauch Chunk and 1100 feet at Broad Top to 283 feet at Altoona and 100 feet at Lock Haven. But the lower red band, the Red Catskill No. IX, does not diminish so rapidly; for, while it is 5000 feet at Mauch Chunk and 4172 feet at Catawissa, it is 2680 feet at Broad Top, 2560 feet at Altoona and 2106 feet at Lock Haven.

The following tables illustrate these variations:

*Anthracite Coal Fields.**

XII.	Conglomerate, ...	at Trevorton	500,	at Mauch Chunk		950
XI.	Mauch Chunk, ...	at Nanticoke	400,	do.		3000
X.	Pocono, ...	at Catawissa	1044,	do.		1300
IX.	Catskill, ...	do.	4172,	do.		5000

* Geol. of Penn'a, Vol. I, Part II, chap. 3.

Bituminous Coal Fields.

XII.	Conglomerate, . . .	Altoona†	223′,	Lock Haven	129′,	Broadtop,*	280′
XI.	Mauch Chunk, . . .	do.	283′,	do.	100′,	. . do.	1100′
X.	Pocono, ...	do.	1274′,	do.	1175′,	. . do.	2133′
IX.	Catskill, ...	do.	2560′,	do.	2106′,	. . do.	2680′

The Conglomerate series is much thinner along the Allegheny mountains than in the anthracite fields, but its rate of thinning is by no means constant.

§ 85. Having shown the relationship of the Lock Haven section to the synchronous formation in eastern Pennsylvania it can now be used as a key to the formations lying west of the mountains.

In going northward from Lock Haven up the Susquehanna river, the descending Hamilton, Portage and Chemung sandstones and shales soon disappear beneath the river bed, dipping quite sharply north by west. They are very beautifully exposed by a series of long cuts on the Philadelphia and Erie railroad.

Overlying them is the great red Catskill formation made prominent and easily defined by its accompanying red soil. It measures 2106 feet in thickness; but as it also dips rather rapidly to the northwest its outcrop soon goes under water level.

The Pocono sandstones next succeed and are finely exposed by natural outcrops in the vicinity of Queen's run. They form the main bench of the Allegheny escarpment.

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* C. A. Ashburner, 1875.

† F. Platt, 1877. [In revising the harmony of these two sections for Mr. Platt's report on Blair county, I am led to give it a very different aspect, and one of great interest to this discussion. It seems to me that we must assume a base for the Pocono No. X in the Broad Top section at the bottom of the 165 foot sandstone (No. 122 on page 208 F) and not at the bottom of the 440 feet of soft rocks (No. 117); for, this subdivision of the column is not only lithologically proper in itself, but brings the Broad Top and Altoona sections into much closer agreement. The resulting measurements are then as follows:

XII.	Conglomerate, .	Altoona, 223′, ...	Broad Top,	280′
XI.	Mauch Chunk, . .	283′, ...		1100′
X.	Pocono, ...	1274′, ...		1545′
IX.	Catskill, ...	2560′, ...		3268′

Showing a remarkable harmony in the rate of thinning of the two formations westward in the fifty miles of interval between the two sections. The facts on which this rectification is based will be given in Report T.—J. P. L.

Overlying them come the red shales of No. XI, here only 100 feet thick, overlaid by the Conglomerate No. XII.

Two miles further up the river, the red shales of No. XI entirely disappear, and their horizon is occupied by sandrocks lithologically indistinguishable from the Conglomerate. The difference between the Pocono and Conglomerate sandrocks which are here seen in juxtaposition is radical. The former are generally fine-grained, though occasionally coarse-grained or even conglomeratic; but the grains of sand are always *rounded*, *dull* and *lusterless*, and usually of a *grayish color*. The sandrocks of the Conglomerate, on the contrary, are composed of *sharp angular* grains, usually *white or yellowish-white* in color.

For eight miles above Queen's run there is apparently no change in the Pocono sandstones. They crop out on both sides of the river from stream level to the summits forming the hillsides capped by the Conglomerate. At Furney's run a few red bands become noticeable in its lower half. These are as often sandstone as shale, and the coloring matter appears to be local as regards each band, but constant in its relation to the formation, always occupying the lower half of what can easily be recognized as Pocono sandstone.

At Hyner's run, Youngwomanstown, Renovo and Keating these reds are very prominent, amounting to about 30 or 40 per cent of the lower half of the formation.

They are characteristically different from the Catskill red bands, being disseminated through the mass, not constant in color, often changing from red to greenish-gray; whereas the red color of the Catskill bands is constant, and (as will be seen from an inspection of the Lock Haven section) is the color of nearly all the layers of that formation.

More than two hundred feet of Catskill red rock is brought above water level near Ritchie by the Hyner anticlinal, and the exposures there show that the character of the formation is the same as that seen at Queen's run.

The Hyner well record shows that there is but little more than 800 feet of red Catskill at Hyner; a most remarkable thinning from 2106 feet at Queen's run, which is only about fifteen miles in an air-line from the former locality.

This rate of diminution prolonged in continuation of a line drawn through Queen's run and Hyner would thin the Red Catskill to a knife edge before reaching Ox Bow bend on Kettle creek.

The exposure of Catskill between Ritchie and Hyner I take to be the most northwesterly one in Pennsylvania. When *its horizon* is brought above water level at Emporium, and in McKean and Warren counties, no trace of it can be found, for there the Lower Pocono sandstones (often red) rest directly upon Chemung shales.

At Keating, Sinnemahoning and Sterling, the reds of the Lower Pocono are quite prominent, often forming arable side hills of red soil in the Sinnemahoning and tributary valleys. The same features are noticeable on Kettle creek. The upper half of the Pocono is not subject to as much change as the lower layers, but preserves its typical character far into Cameron county. It usually consists of hard laminated fine-grained sandstones which when weathered exhibit a peculiarly foliated structure, they are seldom coarse-grained, and the grains are *never angular*. They vary from light gray to a dark steel color, and in some localities have a distinct greenish-gray hue.

At Emporium and north and west from Cameron county the same general features are always presented. The upper part of the Pocono becomes rather softer and more shaly as Warren county is approached, but no sudden change in its thickness can be detected.

The red color of what I consider to be the lower part of the Pocono holds its own throughout the northern part of Elk county, and is again found at Wilcox in the reds of the Wilcox test wells.

The key to the relation of these rocks to the Venango or Clarion County Oil Sand Group is found in the records of the Clarion river test wells, the Nichols, Cooksburg and Tylersburg wells, etc., which show that there is really little change in the thicknesses of the Upper and Lower Pocono from the Ridgway well to the Clarion County Oil Group. The Kane, Sheffield, Stoneham, and Tidioute well-records

furnish another but rather less satisfactory connection to the terminus of the Venango oil-belt at Tidioute.

In the oil regions Mr. Carll shows that there is comparatively little variation in the thickness of the oil group or in the shales overlying it; indeed the measurements from the coal rocks down to the Third oil sand are surprisingly constant. From Oil City to the southern extremity of the Butler County Oil Belt, a distance of about fifty miles, the interval between the Ferriferous Limestone of the Lower Productive Coal measures and the Third Sand is always between 1140 and 1225 feet.

A generalized table of the oil belt stratification shows:

No. XIII.	Lower Productive Coal measures.	
No. XII.	Conglomerate measures, [mountain sands,]	250′—350′
No. XI.	Horizon of red rocks in Clarion county, ...	50′— 75′
No. X.	Shales, containing Third Mt. Sand=Berea Grit, ...	350 —400′
	Oil Sand Group with interstratified red-rocks, ...	300′—450 *
No. VIII.	Chemung sands and shales. [Bradford and Warren oil sands.]	

In Mr. Carll's reports it is shown that the oil sands are replaced by shale and red rock on the eastern side of the oil-belt, and that they shore up on a Chemung floor, sea-bottom or shore-line on the northwestern edge of the productive area; that the Second oil-sand stretches further to the west than the Third, while the First reaches far beyond the Second, and that the heavy red band above it extends as far west as the Ohio line, and is apparently synchronous with the Bedford red-shale.

That the red rocks scattered between the oil-sands and replacing them to the east, are stratigraphically continuous with the red rocks at Wilcox, Emporium, Cameron, Sinnemahoning and Renovo is shown by the sections of Plate VIII, and as these have been shown to be of Lower Pocono age, the oil-sand group, with its overlying red-band must be included in that sub-division.

This nomenclature when carried into Ohio is not at varience with the views advanced by Dr. Newberry who holds that, on palaeontological grounds, the Bedford (red) shale is not Catskill but Subcarboniferous. Nor is it in opposi-

* The maximum thickness assigned to the oil group includes the red band overlying the First oil sand.

tion to Mr. Carll's conclusion that the oil sand-group belongs to the Subcarboniferous era.

The change noticed in the lithological character of the Conglomerate measures, in passing from the Allegheny mountains to Ohio, is less than that of any underlying formation. I have endeavored to show above that the great variation in the thickness of these Subcarboniferous rocks is caused by the Catskill wedging out on a Chemung sea bottom.

Although the Mauch Chunk Red Shale has no existence as a *red* formation in the western counties, it seems to be represented by a band of soft measures subjacent to the Ohio conglomerate. Sections showing this identification have already been published in report VV. on Clarion county.

Resumé.

No. XII. Conglomerate series; a group of sandstones separated by shale and slate with workable coal seams in Western Pennsylvania, 200′—350′.

No. XI. Mauch Chunk Red Shale; locally exhibited as far west as Edenburg and Sligo, in Clarion county; continued as soft shale and slate in the western counties, 50′±.

No. X. Pocono (*Vespertine*) *Sandstone;* consists of two members each 400′± thick from Hymer to the oil country.

Upper or gray Pocono; quite constant at about 400 feet; consists of sandstones in the east and of shales with the Berea Grit in the west.

Lower or red Pocono; 742′ at Lock Haven, and grey in color; its average thickness west of Hyner is about 400 feet, but at the oil-sand shore-line it loses its lower members, and measures but 100 feet or less at the Ohio line.

Its percentage of red gradually increases from 5 per cent. at Queen's run to 75 per cent. in McKean county.

Table showing the proposed nomenclature of the Carboniferous and Devonian rocks of eastern Pennsylvania and Ohio.

	Eastern Pennsylvania.	*Western Pennsylvania.*	*Ohio.*
Carboniferous.	XIII Coal measures.	Coal measures.	Coal measures.
	XII Conglomerate.	Conglomerate series.	Sandstone and shale with coals 1, 2, 3.
Sub-carboniferous	XI Mauch Chunk red shale,	Red or dark shales.	
	X Pocono sandstone.	Upper (gray) Pocono.	Cuyahoga and Berea grit.
		Lower (red) Pocono =oil-sand group.	Bedford shale. Cleveland shale.
Devonian.	IX Catskill.	—absent—	—absent—
	VIII Chemung.	Chemung.	Erie shales.
	VIII Portage.	Portage.	Huron shales.
	VIII Hamilton.	Hamilton, (?)	
	VIII Corniferous limestone.	Corniferous.	Corniferous limestone.

SYNONOMY.

G⁴. 89

The following table shows the measurement of this formation at various points between Lock Haven and Ohio.

	Ohio.	Mercer co.	Forest and Clarion co.	Warren co.	Southern McKean co.	Elk co.	Cameron.	Sinnemahoning.	Hyner.	Lock Haven.
Upper Pocono, . .	250′ ±	400′ ±	400′ ±	300—400	322 ±	407 ±	425 ±	410 ±	390	433
Lower Pocono, . . .	(75)	(75)	450′ ±	0—350′	300	339	347	450 +	600	752
Total Pocono, . .	(waverly) 300—400	475	850	?—750′	700	746	772	850 +	990	1175
Red Catskill, ...	absent	abs.	abs.	absent	abs.	abs.	abs.	abs.?	826	2106′

No. IX Catskill red rock; between Lock Haven and Hyner this formation thins away at a rate of about 75 feet per mile, which if continued would soon cause its total disappearance. This in fact occurs some distance southeast of Cameron, for at that place the red Pocono, as I read it, rests immediately on a Chemung floor.

The geological synchronism as above described will be shown by the table on page 89.

Chapter III.

The Conglomerate Measures No. XII.

Throughout north-western Pennsylvania the Conglomerate is represented by a group of sandstones, sometimes consisting of two or three beds, but often of four, five or six separate rocks, to which the name "Conglomerate Series" has been given. Its sandstones are not usually conglomerates, but each member of the group becomes locally a conglomerate over some area of the north-western counties. They are generally hard, coarse-grained, white, yellowish white, or grayish-white sandstones, rather loose-grained, and are often much stained with ferric oxide. The grains of sand, when coarse, are always sharp, bright and clean, giving to the fractured surface of the stone a distinct and easily recognized appearance altogether different from the Pocono sandstones, the grains of which (excepting the oil sands) are nearly always rounded, dull and lusterless.

Between the individual members of the Conglomerate sporadic beds of coal, iron ore, fireclay and limestone are of frequent occurrence. In the western counties these become quite persistent, and in Ohio are so regular and reliable that they have been mistaken for a part of the Coal measures proper.

The compound character of the Conglomerate I first suspected in the fall of 1875 from the data obtained by a survey of that formation along the Beaver and Shenango rivers, a full description of which is given in Report V. Mr. Carll, on entirely independent grounds, arrived at a similar conclusion the same year, and it has been again redemonstrated by Mr. I. C. White in Reports Q and QQ,* and by Mr. Ashburner in Report R.

* In which reports the Conglomerate Series is called the Beaver River Group.

In Clinton, Cameron, Elk and McKean counties the series is much more variable in thickness than in the western counties. It is apparently thicker throughout the oil district—especially in Venango county—than in Elk or McKean county, and is thinner along the face of the Allegheny escarpment than at Renovo or Keating, but from Renovo to Kane its thickness is apparently quite uniform.

In the gaps in Chestnut and Laurel ridges in Westmoreland and Indiana counties Mr. Stevenson and Mr. Platt have shown that Bed A comes much nearer to the sub-carboniferous limestones and red shales, being separated from them by one, coarse, massive sandstone which is apparently the Homewood or Piedmont rock, whereas in Lawrence, Butler, Mercer, Crawford and Venango what is supposed to be the same coal bed is always at least 250 feet—and generally is fully 300 feet—above the sub-carboniferous (Pocono) shales.

Over what extent of counties this condition of things exists cannot be known, because the Conglomerate is deeply buried. But where it outcrops along the Allegheny mountain No. XII exhibits its usual thickness; increased to 500 feet around the Cumberland basin; and to 1000 feet in West Virginia. If the exhibition in the Laurel hill and Chestnut ridge gaps be significant of the character of the whole central region, it indicates that the lower members of the Conglomerate group were deposited only around the margin of the Coal field, and that only the upper member was deposited universally over the whole Coal field.

§ 86. The following statement of observations made along the valley of the West Branch Susquehanna will give a clearer notion of the condition of the formation in the north.

On Queen's Run there is a local re-placement of the lower part of No. XII by the red shales of No. XI, its total thickness measuring but 129 feet. In less than a mile, the red shale totally disappears and in its horizon are hard massive sandstones, evidently belonging to the Conglomerate measures.

At Farrandsville, on the Switch-back railroad, there is

about 220 feet of sandstones belonging to No. XII. The lowermost 70 feet of this has a transitional character, being lithologically neither Pocono nor Conglomerate. No sign of the Mauch Chunk Red Shale can be detected on this side of the river. From Farrandsville northward to Furney's run no reliable section of No. XII can be obtained.

At Glen Union the conglomerate has a thickness of about 220 feet, 120 feet of which is well exposed. It is immediately underlaid by hard grey Pocono sandstone.

On Rattlesnake Run near Wetham similar exposures can be seen in several places but no continuous section of the group (No. XII) was obtainable.

From Hyner to Renovo, and for some distance west of the latter place, the lower member of the group is a hard massive sandstone from thirty to forty feet thick, always making a prominent bench terrace at its out-crop. Above this stratum there are three massive beds of hard whitish sandstone, parted by bands of soft shale. A thin coal seam occurs between the uppermost rock and that beneath it. At Renovo the total thickness of the group is 245 feet.

At Keating the exposures are very imperfect, but enough was seen to determine the total measurement of the group, (which is composed of five or six sandstones), to be about 250 feet. A thin coal bed here underlies the top rock of the group, and a bed of bituminous shale or impure coal is found beneath the second stratum.

At Sinnemahoning the top member of the series lies higher than the hill-tops. Three bands of hard, coarse grained sandstone included in an interval of 200 feet, cap the highest hills. They contain no coal beds. Immediately beneath them are the hard gray Pocono sandstones, which crop out in bold cliffs from 50 to seventy feet high. A trace of the Mauch Chunk Red Shale was noticed on top these cliffs, but it cannot exceed five or ten feet in thickness.

At Sterling there are very similar exposures of the Conglomerate group but the gray Pocono sandstones are not so prominent as at Sinnemahoning. This is probably due to difference in erosion, and not to any lithological change in the formation.

At Cameron the exposures are poor. A mass of sandy measures nearly 200 feet thick underlies the lowest coal bed. This bed probably belongs to the group, and it is possible that the two or three lower coals should be included in it, swelling its measurement to ever 250 feet.

From Cameron to Emporium the rise is very rapid, averaging probably about 250 or 300 feet per mile, which carries the Conglomerate up so rapidly that before reaching Emporium it passes out of the hill-tops. At Cameron no red is noticeable beneath it, but three miles further up the stream it is underlaid by at least twenty feet of the Mauch Chunk Red Shale.

At Rathbun the base of the series lies from 350 to 400 feet above railroad level. Three bands of hard coarse sandstone are partly exposed. In the upper interval a thin coal bed has been found.

At St. Mary's there is about 210 feet which M. Ashburner refers to the Conglomerate measures. This interval includes four sandy horizons and three thin coal seams. The coals are all only locally workable, but have been mined quite largely. The conglomerate here rests on local patches of the Mauch Chunk Red Shale.

Throughout McKean County Mr. Ashburner finds that the Conglomerate group is composed of three or more sandstones, the lower member being the coarse Olean conglomerate (although that rock is often a fine-grained sandstone) separated by shales and slates with coals of workable thickness. He estimates the total measurement of the group to be from 180 to 220 feet. It probably approximates the latter figure over the greater part of the county.

At Kinzua on the Allegheny River in Warren county, there is a magnificent exposure of this group and the underlying rocks. The group throughout contains an extraordinary amount of conglomerate. Its lowest member, the Olean conglomerate (Second mountain sand or Ohio conglomerate) is a solid mass of conglomerate, very coarse at the base, and outcrops in vertical cliffs from 77 to 80 feet high. Its total measurement is over 350 feet.

In the oil regions of Venango county Mr. Carll makes his

Mountain Sandstone (No. XII) series about 400 feet thick by lowering its base so as to include the Shenango sandstone (Sub-olean conglomerate.)

As the character of the group in the western counties has already been discussed in Report V, no further description of it is necessary. The following table shows the relation of these rocks to the overlying coal measures of the western counties:

Freeport coal group, .	Allegheny River Series of No. XIII.
Kittanning coal group,	
Clarion coal group, .	
Homewood sandstone, ...	Conglomerate Series No. XII.
Mercer coal group, ...	
Connoquenessing sandstones, ...	
Sharon coal group, ...	
Sharon, Garland, Olean Conglomerate,	

Chapter IV.

Mauch Chunk (Umbral) Red Shale, No. XI.

§ 87. A thickness of one hundred feet has been assigned to this formation in the Lock Haven section, but this thickness is purely local, as the rock thins away to nothing in a distance of from one and a half to two miles, and its horizon is there occupied by the lower members of the Conglomerate.

It is possible that west of the Allegheny escarpment, the only part of this formation present is the uppermost portion, which would correspond to the transition layers in the east.

At Snow Shoe there is certainly more than one hundred feet of red shale at this horizon, but it is impossible to make an accurate measurement of it in that locality.

At Altoona it is much thicker, approximating three hundred feet. Going eastward it rapidly thickens, until at Broad Top it measures 1100 feet. The presence of lime-

stones, together with its rapid increase in thickness at the latter place, may indicate that in this direction the basin deepened rapidly. South and south-west from Altoona it is also probable that there was a comparatively deep basin during this period, but to the north and north-west the sea shoaled, and was disturbed by swift currents which ushered in the Conglomerate epoch.

On the Tangascootack no red shale has ever been found, but on the eastern face of the mountains near Revilletown it is from 50 to 100 feet thick. At Glen Union and Wetham it could not be detected, but as the exposures are quite poor for some distance beneath the Conglomerate, its outcrop may be hidden.

A very thin band of red shale underlies the Conglomerate at Hyner, but it was not visible at Keating, Sterling or Cameron.

At Sinnemahoning and at Emporium a thin layer of red shale or red clay frequently occurs at this horizon on the hilltops, making small areas of red soil.

It is also seen at St. Mary's and at Johnsonburg, but is so thin and so inconstant that to speak of it as a continuous formation is hardly justifiable.

West of the Johnsonburg (Elk county) Coal Basin it is not often seen. It has been found in the oil regions as far west as Edenburg. It is not recognized in Ohio, but it may be represented by the soft grayish shales found immediately beneath the Ohio (Sharon) Conglomerate.*

Its western limit *as a red shale* may therefore be placed at the Sixth Coal Basin.

South-west of this trough it has been shown to be very thin and always distributed in local patches. Over this area it was either deposited as a thin sheet and subsequently eroded, or, as seems most plausible, was brought in and deposited in isolated mud bars simultaneously with the first deposition of conglomerate. It may have been derived from the original source of the red deposits of this age, or may have been gathered up from a partial erosion of the red rocks already formed, or may have retained its red color from some local lack of per-oxidising reagents.

* See Report VV for a discussion of this horizon.

Chapter V.

Pocono (*Vespertine*) *Sandstone, No. X.*

§ 88. This rock is persistent from Eastern New York through Pennsylvania and Ohio to the Cincinnati anticlinal.

In the Eastern, Central and Southern portions of the State it is a hard massive sandstone often coarse grained and conglomeritic, from 1200 to 2500 feet thick; but, going westward toward the oil regions it becomes finer grained, its lower half assumes a red character, while the upper part is in places almost entirely composed of soft shales.

Three hundred feet of its lowermost layers I consider lost against a Chemung floor (or ancient sea shore) in the oil district, allowing only the uppermost 400 feet of it to reach the Ohio line.

At Lock Haven its total thickness is 1175 feet (which does not differ much from Mr. Sanders' measurement of it at Altoona,) consisting of hard massive gray sandstones separated by beds of softer sandstone and shale. In one of its upper bands a thin bed of bituminous (cannel) slate occurs.

Just below its junction with the Mauch Chunk Red Shale there is a thin layer of *limestone.*

Its division into two members is not very prominently shown at Lock Haven by any marked lithological difference between its upper and lower portions, but west from Queen's Run the two subdivisions are always distinguishable by the prominent red color of its lower half, when contrasted with the overlying gray strata.

This differentiation of the rock seems to me to give us an important geological horizon separating the Venango Oil Sand Group from the measures above it.

In McKean and Elk counties this lower red portion of the

Pocono has been called red Catskill by Mr. Ashburner, but that nomenclature has not been adopted in this report because I do not think that it maintains the exact equivalency of the rocks described with those of Eastern Pennsylvania.

The Upper or Grey Pocono.

§ 89. The characteristic feature of this sub-division from Lock Haven westward to Emporium, is its constant sandy character. The sandstones are nearly all *hard and massive*, but are usually quite *fine grained* and exhibit *a foliated or laminated structure*, which in weathered outcrops often gives one the impression that they are a sandy slate. Their color is always some shade of gray, sometimes approaching a dark steel color, but is usually a greenish gray. The sand grains are rounded, of rather dark color, lusterless and are never sharp. About 60 to 80 per cent. of the mass is composed of sandstone, and the remainder of sandy shale.

From Emporium westward, it rapidly becomes less arenaceous, the sandy bands fining down into sandy shales, and the shaly bands between them thickening, until in some localities more than half of the hard sandstone has been replaced by olive and gray shales.

In the Oil region this horizon is noted for its universal softness, fast drilling time always being made between the conglomerate or Mountain-sands and the Oil-sands. It includes but one persistent sandy horizon, that of the Third mountain sand or Berea grit.

The following table shows its approximate thickness at prominent localities along the line of section:

Queen's run,	433′	Emporium,	500′?
Farrandsville,	base unexposed.	Rathburn,	390′+
Wetham,	400′	Ridgway,	407′
Hyner,	390′	Wilcox,	322′±
Renovo,	400′±	Kane,	350′±
Keating,	375 ±	Warren county,	250′ to 400′
Sinnemahoning,	410 ±	Clarion county,	400′±
Sterling,	360′+	Mercer county,	400′±
Cameron,	425′		

The parallelism shown by the above table is certainly very remarkable when we consider the distance over which it

extends. But it is no more wonderful than the parallelism exhibited by the Coal measures of the bituminous coal basins. The identity of this subdivision with the Waverly of Ohio does not depend altogether upon the proof afforded by the stratigraphical method adopted in this survey, but is also supported by palæontological evidence, for Waverly fossils can be traced at this horizon uninterruptedly from Ohio to McKean county.

The Lower or Red Pocono.

§ 90. Along the face of the Allegheny mountains this subdivision of the Pocono is indistinguishable from the upper. They are so similar, lithologically, that any division made between them is purely artificial.

A trace of red shale occurs here and there throughout the formation, but can hardly be said to be more prominent in the lower than in the upper half of the rock. Going westward the red bands rapidly increase in number and in thickness until at Hyner they aggregate one third of the whole mass.

The red color in any one stratum cannot be considered constant, as it is constantly giving place to olive or to gray, and this often quite abruptly. But as a whole the formation has a distinctly red character in all the country northwest from Wetham or Ritchie.

The following table is given to show in a general way that the red color increases from east to west, until from merely a trace at Lock Haven it becomes the predominating color in Cameron and McKean counties. It must not be supposed that this change is regular; nor that the red rocks *swell in thickness* towards the northwest; it is only intended to indicate that there is a radical *change of color* in this subdivision between the Allegheny mountains and McKean county.

Queen's run	about	5	per cent.	of red.
Furney's run	"	10(?)	"	"
Hyner	"	36	"	"
Sinnemahoning	"	42	"	"
Cameron	"	60	"	"
Wilcox	"	75	"	"

This might be continued westward by tables for the oil regions, but in that direction we are approaching a belt of variations along which the greatest irregularity prevails. It is certain, I think, that these reds, with the exception of the uppermost band, thin out between the oil sands of Venango, Clarion and Butler county, and must be considered as geologically synchronous with them.

The heavy red band overlying the First oil sand, which is well developed at Franklin, Reno, Milton, Fosters, Scrubgrass and Raymilton, extends far to the west, having been found in wells drilled on Slippery Rock creek, and at New Castle at about the same geological horizon, although a few feet closer to the Conglomerate than in the oil regions.* It is undoubtedly the eastward extension (although perhaps at a lower geological level) of the Bedford shale of Ohio.

The reds of this rock are also found higher (or closer to the Conglomerate) at Bradford and throughout the northern part of McKean county than at points further south. In fact everything that can be seen throughout that part of the country tends to prove that *the horizon at which the red color predominate, constantly rises in a north and northwesterly direction.* This has been noticed by Mr. Ashburner, but he has drawn a rather different conclusion from what he has seen, viz: That the change detected is *not* a shifting of the horizon of the red color, but a *bona-fide* nonconformability between the red rocks and overlying strata.† On this view he makes the reds of McKean county, which are here classed as Red Pocono, continuous with the red Catskill.

In the following table the thickness of this group is given for all the important localities on the line of section. The only abrupt change occurs at the oil district and in the prolongation of the Venango oil belt.

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*This is fully described in Report V.

†Not necessarily by erosion, but by a thinning westward and northward of the interval rocks between these red beds of X (or IX as he views them) and XII.

Queen's Run, ... 742′	Ridgeway, about . . 339′
Hyner, ... 600′	[Wilcox, about . . . 290′+]
Sinnemahoning, . . . 450′+	[Kane, about . . . . 160′(?)]
Sterling, ... 450′±	[Bradford, about . . 250′±]
Cameron, ... 347′	Venango county, 300 to 450′
Emporium, (about,) . 375′	Mercer county, . . . 75′±

It will be noticed that from Wilcox to Bradford the group is thinner than either southeast or southwest of those points. This is readily understood by reference to the map, by which it will be seen that those places lie off to the north and entirely on one side of the line along which most of the sections are located.

At Kinzua and at Warren the group is almost if not entirely wanting. These places lie *west* of the prolongation of the Oil-sand shore which, I take it, ran a short distance east of them, east also of Stoneham (?), slightly west of Kane, and not far from Bradford.

In some parts of Venango and Butler counties the thickness of this group is apparently augmented by bands of red rock coming in beneath the Oil-sands; or, it is possible that these may be the wedge-shaped ends of the Red Catskill; but our data are unreliable for demonstrating the truth of either hypothesis.

Chapter VI.

Catskill (Ponent) red sandstone, No. IX.

§ 91. This, the "Old Red Sandstone," has its greatest thickness in the Second mountain at the Susquehanna river where it is nearly six thousand feet thick.

At Broadtop and Altoona it is a very prominent member of the Palæozoic series, made so principally by its characteristic bright red color. Along the Allegheny escarpment it always forms high but smoothly eroded foot hills, the red color of which is a prominent feature in the scenery of the

Allegheny mountain from the Susquehanna river to the Maryland State line.

At Queen's Run it is finely exposed by a series of natural outcrops along the river bank, and consists of red shale and red sandstone in nearly equal proportions, with here and there a layer of gray sandstone. Over ninety per cent. of the whole mass—which measures 2106 feet—is red.

Going westward from Queen's Run its thickness diminishes quite rapidly, for at Hyner it measures but 826 feet.

Thinning at this rate it should entirely wedge out in a few miles, but as its horizon is entirely beneath water level from Hyner to Emporium, its northwestern limits cannot be determined.

At Cameron the record of an old test well shows that it is absent, for the red passed through in the well belongs, I think, to the Red Pocono. In the Kettle Creek well but little red was found. This well started near the top of the Red Catskill.

At Ritchie (near Hyner) the Hyner anticlinal brings about two hundred and fifty feet of this rock above water level. It here *shows exactly the same character as at Queen's Run.* The following section, though not very accurately measured, fairly describes the exposures seen in going from the crest of the Hyner anticlinal to Ritchie. The dip is strong enough for the succession given below to be recognized in passing the exposures in the railroad cars:

Ritchie Section.

Feet.

12. Sandstone, hard and massive, greenish gray, micaceous.
7. Red and olive shale, soft.
20. Shale, gray and olive, with some sandstone.
25. Sandstone, hard, massive and gray, replaced in 50 ft. by red shale and SS.
35. Red shale, soft.
25. Red shale (soft), with red sandstone.
12. Red sandstone, massive.
22. Red shale, soft.
18. Red sandstone, hard coarse and micaceous.

25. Concealed. (Red SS. and shale?).
2. Red sandstone, shaly.
15. Red shale.
5. Grayish red sandstone.
20. Red shale, soft.
15. Red sandstone, hard; lowest layer exposed on the crest of the Hyner anticlinal.

I think it probable that the uppermost sixty-four feet of the foregoing section should be assigned to the Lower or Red Pocono. The description is given mainly for the purpose of illustrating the difference (lithologically) between the Red Catskill and the Red Pocono. The latter barely contains a high enough percentage of red measures to warrant its being called a red formation at Hyner, whereas the Red Catskill is *nearly all* red.

Were these red bands found throughout the western counties a westwardly continuation of the Red Catskill, it seems at least probable that some of the *Catskill fish* remains would be found in them. At Queen's Run the Catskill does contain *fish-beds*, and these are also found in Bradford and some other northern counties, as well as in the south-eastern counties in New York State. But none are reported from the red rocks of the western counties, and the Bedford red shale of Ohio is said to be entirely destitute of Catskill fossils.

It seems to me incredible that if the Catskill really extended so far to the west, as a red formation, it should not yield these characteristic Catskill fossils; for though *shell-fish* may be limited to certain areas in which the conditions necessary to their growth obtain, no such limitation can be assigned to the possible extension of the domain of fish endowed with rapid and voluntary locomotive powers. The absence of their remains in our western red bands can therefore be taken, I think, as *prima facie* evidence that these rocks belong to a different age.

Chapter VII.

Chemung and Portage—Upper part of No. VIII.

§ 92. These are concealed from view beneath water-level from Lock Haven to Emporium; but at two points, Hyner and Cameron, they have been penetrated by test wells, the records of which furnish some knowledge of their lithology.

The Chemung is magnificently exposed above Lock Haven in the railroad cuttings, where it consists of an alternation of gray sandstones, olive and gray shales and slates, with an occasional layer of red or purple slate or sandstone. The Portage cannot be recognized as such, and has been grouped with the Chemung in the Lock Haven section in Chapter IX. The combined thickness of the two is 3314 feet.

§ 93. The Chemung and Portage *red bands* are unlike the Catskill reds and need never be mistaken for them.

They are usually of a dark purple or purplish red, and show no red color on their weathered surfaces. When churned up with water in the bottom of a well the coloring matter becomes quite prominent, but they seldom give the blood red tinge to sand pumpings that is always characteristic of the Catskill and Pocono red rocks.

The first red horizon in the Chemung occurs about 400 feet beneath the top of the formation. It is usually quite thin, but in some localities being composed of a number of thin red bands it is given quite a considerable thickness in oil well records.

The Bradford oil sand group is probably of Chemung age, but possibly upper Portage.

§ 94. Mr. Carll's researches along the State line show that the Conglomerate of the Salamanca Rock city, as well as the Frewsburg and Panama Conglomerates, are all of Chemung age. As these rocks either fine down into fine-

grained micaceous sandstones southward and southeastward or are unrecognizable in the deeper oil wells, they seem to indicate the existence of a Chemung shore towards the north. The Panama Conglomerate has been suspected to be one of the Venango oil sands, but Mr. Carll shows that the dip would carry it far beneath the Third oil sand, that there is no *red* beneath it, and that it is overlaid by Chemung shales.

Chapter VIII.

*Theory of the Sub-Carboniferous deposits.**

§ 95. *The Catskill Basin.*—In the southeastern part of the State of New York the *erosion limit* of the Catskill formation, No. IX, is along the northern face of the Catskill mountains, between the Hudson and Delaware rivers. How far its deposits extended towards the Adirondack mountains and Lake Ontario cannot be known.

The numerous peaks of the Catskill mountains are patches of Pocono sandstone, No. X, which have escaped the general erosion of the country. These rise a thousand feet above the Catskill plateau and show how thick the Pocono formation must have been. But the transition from Catskill to Pocono in that region has not been studied.

The Pocono plateau in Pennsylvania, between the Delaware and Lehigh rivers, consists of 1300 feet of Pocono sandstones, No X, lying upon 5000 feet of Catskill sandstones, No. IX.† Softer transition strata exist; as is shown by the depression between the two crests of the Second mountain, between the Lehigh and Little Schuylkill rivers.

Both the Pocono and the Catskill formations are repeatedly exhibited in bold exposures along the Lehigh, the North Branch Susquehanna and the Tioga rivers, from Mauch Chunk northwestward to the New York State line. Both of them diminish in thickness in that direction, thus:

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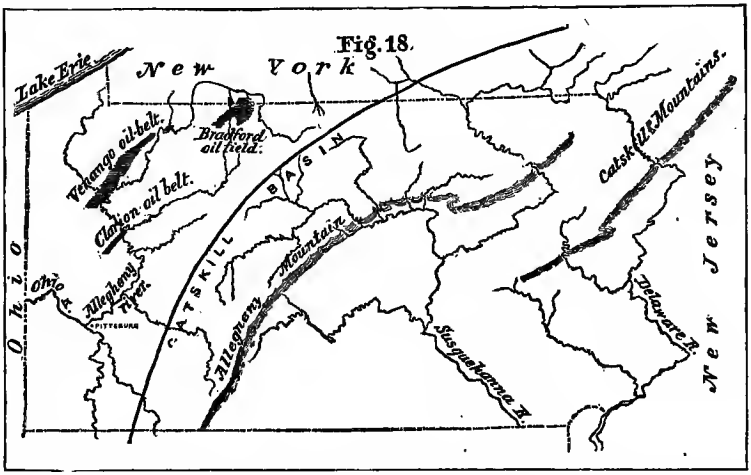
* In presenting the views advanced in the following pages I must disclaim originality in the theory of a Chemung shore-line deposition of the Venango oil sands, which was first advanced and supported by Mr. Carll; but the facts obtained in collecting the data for this Report (see sections in Chap. X) seem to corroborate his conclusions.

† There is no good opportunity for measurement of the horizontal plateau rocks; but at Mauch Chunk they are turned up vertical and can be measured with precision in the gap of the Lehigh.

The Pocono (X) is 1300′ at Mauch Chunk, 1100′ in the Nescopec mountain, 600′ in the Shickshinny mountain near Wilkes-Barre, and still less in Tioga and Bradford counties.

The Catskill (IX) is 5000′ at Mauch Chunk, 4000′ at Catawissa, 2500′ at Wilkes-Barre, 1500′ at Tunkhannock, and only 400′ or 500′ in Tioga county.*

This diminution of thickness northwestward must of course indicate an ancient *sedimentary limit* running through the State of New York, southwestward, into Pennsylvania, as represented in Fig. 18.



§ 96. Such a limit my observations compel me to locate with some degree of precision as crossing Kettle creek at the Ox Bow bend, in Clinton county.

Sweeping westward from Ox Bow it passed somewhere to the south of Sterling, (for at Cameron No. IX is entirely absent) and curving slightly southwest became more nearly

[* Prof. White's recent work in the northern counties leads him, however, to believe that the old measurements have been much underestimated. He finds the Catskill 1200′ thick at Blossburg, *i. e.* 900′ above and say 300′ beneath the Mansfield fishhed. He makes the interval from the Catskill up to the Conglomerate there about 800′ (possibly 1000′) which would leave for the Pocono 450′ (possibly 650′). In Susquehanna county, much further east, he has measured 2000′ of what he considers Catskill, with more to be added above.—J. P. L.]

parallel to the oil-sand shore-line. At the Forest county line its normal southwesterly sweep began to re-assert itself, and the limit of the basin through Forest, Clarion and Venango counties seems to have been approximately parallel to the present sweep of the oil-sand belts.

By reference to the map it will be noticed that the shape of this basin rudely conforms to the trend of the Bradford oil belt. This is strong proof that the basin is rightly located, for the Bradford sand is of Chemung age, and its trend or line of uniform character indicates (as it must conform to) the shape of the Chemung sea-bottom or sea-shore during its deposition. As the change from Chemung to Catskill was a comparatively gradual one, and as we have no proof of any sudden revolutionary change during that transition period, we should naturally expect to find the general features of the former reflected in a complementary manner by the latter.

The western edge of the basin, if a shore, was probably broken by bays, which may have extended in some places west of the Venango Oil Sand belt; and these when filled with red sediment would show, as we now find, red rocks beneath the oil sands. Or it is possible that this edge may have extended beyond the line of the oil belt and that the "Third Sand" shored on Catskill, while the "Second" and "First Sands" were formed on Chemung. Again, the edge of the Catskill basin may not have been a shore line, but simply a subaqueous escarpment or bench of Chemung with side ravines and valleys in which the red extended further west than along the normal limit of the basin; or finally the Red Catskill may never have reached so far west.

The Oil Sand Shore.

§ 97. It seems certain that whether the edge of the Catskill was or was not a shore line, a shore was soon after formed by the emergence of Chemung rocks at and west of the present oil belt. On this shore the oil sands were progressively formed, the "Third" first and the "First" last, at different elevations; a gradual subsidence taking place during their deposition.

Simultaneously with the formation of the oil sands, the red and gray rocks of the Lower (red) Pocono were being deposited along and for a certain distance off the shore, while at a still greater distance eastward were currents throwing down the hard massive sandstones found in the lower part of the Pocono in eastern Pennsylvania.

That the deposition of red should not stop abruptly at the close of the red Catskill epoch, but continue over a limited area during a portion of the Pocono age, is not surprising, for there is no evidence of any radical change in the relations of land and sea at this time, such as would explain a *total* and *sudden cessation* of the red material that had previously been coming into this basin.

In any off-shore deposits, other things being equal, the line of constant lithology will approximately conform to the general trend of the beach. It then follows that the most characteristically red part of the Lower Pocono will always be found at a certain distance from the oil-sand shore. But this shore was a sinking shore, and as the beach-line moved further and further west during the formation of the oil sands, the area over which red was depositing could only keep an unaltered position with reference to the shore by moving westward with it.

After the First sand had been formed a comparatively slight subsidence took place, but the land was so extremely flat (resembling the tertiary flats of the Atlantic coast) that the shore was thrown far west of the Pennsylvania line into Ohio. Its character may have been so altered by such a radical change in its eastern slopes, (which were now changed to broad mud shoals, that no beach of any prominence was formed along its line in Central Ohio.

The horizon of the red was of course carried westward by this progression, and in its gradual recession has left over some areas a solid band of red shale 100 feet thick resting upon the First oil sand. In Ohio this is known as the Bedford shale and is about 75 feet thick. The Cleveland shale was probably deposited in comparatively still water before the red color had reached so far west as Ohio.

I judge, therefore, that we have no Cleveland shale in Pennsylvania.

The deposition of red must have extended through a very long period, for from the close of the Chemung age until the cessation of red deposits at the top of the Bedford (which I consider continuous with the middle part of the Pocono No X) there is embraced not only all of the Catskill age but half of the Pocono.

§ 98. Viewed in this light, it seems to me easy to understand why the paleontological divisions are so sharp in Ohio and so ill-defined in northern Pennsylvania. In Ohio the break between the Bedford, which shows sub-carboniferous fossils only, and the Chemung, is strongly marked, and this is precisely what we should expect if the Bedford is the last representative of the Catskill reds, and was deposited in middle Pocono age.

After the Bedford shale had been laid down a more rapid subsidence occurred (this may have cut off from Ohio and Pennsylvania what little red was still coming into the sea) and the Waverly group began to form. Although this submergence began at the close of the Bedford age, it probably did not affect Ohio at that time, but was rather an emergence there, while a subsidence was progressive in Pennsylvania.

In the latter State 100 feet of shaly measures were laid down on the red bands, while in Ohio the Berea Grit was being deposited in the north, and (mayhap prior to it) the Waverly Conglomerate in the south. While the Berea shore-line was yet unchanged the Third mountain sand was thrown down in the oil regions, while east of that area, finer-grained greenish gray sandstones were being deposited in the deeper water, and harder and coarser sandstones were laid down by swifter currents still further east. The sediments in eastern Pennsylvania were of this character, and being laid down in what was comparatively deep water (with reference to the western shoal water deposits) were not much affected by these oscillations of the ocean bed that produced such constant changes along the shore from

the time of the deposition of the Third oil sand to the end of the Waverly (upper Pocono) age.

At the close of the Waverly another emergence took place in Western Pennsylvania and Ohio, with probably a complementary submergence of central and eastern Pennsylvania, while very deep water covered the Pocono to the south and southwest.

§ 99. Another era of red deposits now recurred, which presented many features similar to that of Catskill age; and just here the question is suggested:—Is not the Mauch Chunk red shale but a continuation upwards of the Red Catskill? We have traced this red into middle Pocono in Ohio, but there we were abruptly stopped by a total erosion of these measures from the surface. It does not seem improbable that, could we trace the Bedford red from the Vermillion river across Lake Erie northward into Canada, its horizon might be found at a geologically higher and higher level until it would finally occupy the horizon of the Mauch Chunk Red Shale (XI) immediately beneath the Conglomerate; provided that the Conglomerate measures ever extended so far northwestwardly.

The Pocono red bands not Catskill.

Perhaps it has not been made perfectly clear, why the red rocks of Potter, Clinton, Cameron, McKean, and Venango counties, have been classed as Lower Pocono, instead of Catskill, and for this purpose the following facts are restated:

First. At Hyner red bands are found in the Pocono measures up to within 400 feet of the conglomerate, but they do not resemble Catskill, in that only one third the strata containing them is red, whereas the great bulk of the mass is typical Pocono, while *beneath* this there *does occur*, above water-level, over two hundred feet of true Catskill red rock. The conclusion therefore follows that the upper mass is Pocono of somewhat changed lithology.

Second. If the upper red bands at Hyner were Red Catskill, we should expect to find between Hyner and Lock Haven an increase in the amount of red, and for 300 or 400

feet above water-level at Furney's run the rocks should be very prominently red. The reverse of this is true, there being no appearance of Catskill at Furney's, which is but 9 miles from Queen's run, where the Catskill is such a characteristically red formation, containing about 90 per cent. of red strata.

Third. The upper reds (Lower Pocono) at Hyner can be traced continuously to Emporium by actual exposures, and the Emporium red rocks can be shown to be the same with those of McKean and western Potter counties.

Fourth. Measurements of the Red Catskill between the face of the Allegheny mountains and twenty or thirty miles west of the escarpment show a rate of thinning that would cause it, if continued, to disappear before reaching the northern and western counties.

Fifth. The Pocono does *not* thin at such a rapid rate as the Catskill. If the Hyner red rocks are red Catskill, the Pocono must thin from 1175 to 400 feet in fifteen miles. At this rate it would entirely disappear five miles from Hyner.

Sixth. If the McKean red rocks are Catskill, then the Bedford is Catskill, for it can be traced by well records continuously from Bradford to Ohio. This conclusion is antagonistic to the views held by the Ohio geologists.

Seventh. These Pocono red bands are geologically synchronous with the oil bands of Venango county, which Mr. Carll considers of Sub-carboniferous and not Devonian age.

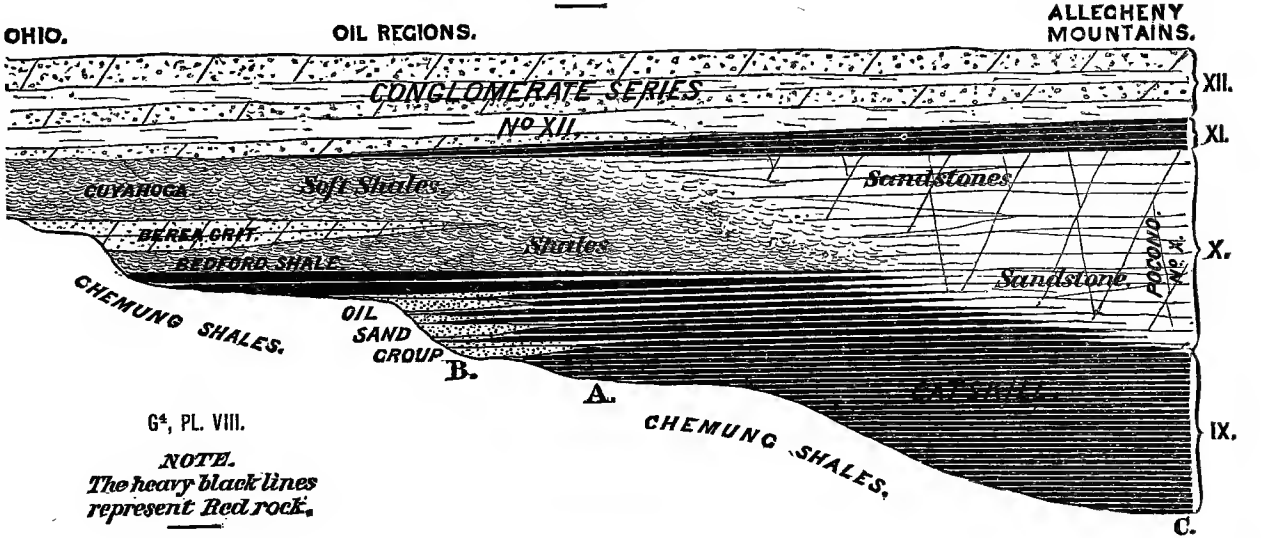
Eighth. In the measures lying within 800 feet of the base of No. XII, which includes the Bradford red rocks, in McKean county, Mr. Ashburner states that there have been found 18 Waverly, 7 Chemung and 1 carboniferous species of fossils, which is certainly corroberative of the conclusion that the McKean county red bands are sub-carboniferous, *i. e.* Pocono, not Catskill.

The ideal sketch shown by Plate VIII is designed to illustrate the shifting of the red colored deposits from rocks of Catskill to those of Pocono age.

At the close of the Catskill age the western edge of the red rocks was at the point A, but subsequently, owing to a subsidence and a new shore, it moved westward and was

Theoretical Diagram illustrating the depositon of the Catskill and Pocono Red beds, by

H.M. Chance.



G⁴, PL. VIII.

NOTE.
The heavy black lines represent Red rock.

O.S.H. del.

limited by the oil sand shore at B. After the oil sands had been deposited, a further submergence threw the shore far to the west, and the red lapped over into Ohio.

In the accompanying plate the measures are represented as though perfectly horizontal, but that that is not true to nature is evident, for the sea bottom at any and every age must have had some slope, and the point C was, throughout the Pocono epoch, more deeply submerged than a corresponding horizon at B.

Chapter IX.

The Plate of Vertical Sections.

The sections embraced in this illustration have not been arranged side by side according to any fixed geological horizon. It has not been possible to determine the place of any one stratum exactly in all of the sections, and for this reason they have been so placed that a comparison between any two or three may be most easily made.

The most easterly section, that at Queen's run, contains sufficient red at the horizon of No. XI to fix with a fair degree of accuracy the base of the Conglomerate measures. Beneath the red masses of No. XI come the hard fine-grained but sometimes conglomerate Pocono sandstones whose base may be placed at the bottom of the 285 foot interval, but the lithological character of the next 185′ of measures seems to indicate that they too should be included in this division. This 185′ may however be referred to a transition period. Beneath it is the Catskill red rock of great thickness underlaid by Chemung shales.

In the lower two-thirds of the Pocono Sandstone several thin red bands are noted.

The Wetham section is very defective. The Mauch Chunk red Shale (XI) is not shown and the Pocono Upper sandstones seem to be in juxtaposition with the Conglomerate measures. The 400′ of sandstone is somewhat broken by shaly layers, but is almost entirely free from red bands.

The reds of the Pocono Lower sandstone were detected beneath it, but the Wetham synclinal sinks most of this subdivision beneath water level.

The Hyner section embodies the data obtained in sectioning at Hyner, Youngwomanstown and Renovo. It shows the horizon of No. XI by red layers occurring beneath a hard, massive, escarpment-forming sandrock easily recognized at all of the above named places.

The lower division of the Pocono apparently begins at the 20′ red band and extends down to the well. The red Catskill was perforated from top to bottom by the well which also penetrated 1187 feet into gray Chemung measures.

From Renovo to Keating no good sections could be had, and at the latter place the section is not very satisfactory. It does not clearly define the division between the Conglomerate and Pocono, no appearance of Mauch Chunk red rock having been noted. The lower reds of the Pocono are shown for a short distance above water level.

In the next section No. XI is shown by two thin red bands; and the red character of the Lower Pocono contrasted with the gray of the Upper division furnishes a good plane of demarcation between the two.

At Sterling the same general features are reproduced but I failed to find the Mauch Chunk red shale (XI), the Conglomerate and Pocono sandstones appearing in juxtaposition as at Keating and Wetham. The same difficulty was encountered at Cameron, but here a band of soft rocks separating into two divisions the 125′ interval seems a tolerably sure indication of the horizon of No. XI, for it exactly corresponds to the horizon of the Emporium junction red band when brought down on the dip of the lower red layers.

The alternations of red and gray in the Pocono Lower sandstone division is well shown in the Cameron record, and this also shows that these reds here rest directly on Chemung, as they also do at Emporium where they lie far above water level and may be studied to better advantage.

The exposures at Rathburn furnished an unsatisfactory section which fails to define the horizon of the Mauch Chunk red shale.

At Ridgeway we find all the features of the Emporium and Cameron sections reproduced; although the Mauch Chunk is not shown as red shale, I think its horizon in the 45′ interval is tolerably certain. The 12′ rock beneath it is a flat pebble conglomerate in which Mr. Ashburner recognizes his Sub-olean (the equivalent of the Shenango sandstone) shown

by the 50′ rock in the Smith well, the 32′ rock at Kinzua and the 45′ rock at Marion.

The Wilcox section lies much further north than Ridgway, and here the Pocono red bands occur at a much higher geological level. The approximate position of the base of No. XII is merely indicated on the hillside above the well. If the Dennis well-record were introduced beside this Wilcox section it would show the Pocono reds at a still higher level.

At Marion, which lies west and south from Wilcox and nearly west from Ridgeway, we find the features of the Cameron and Emporium sections nearly reproduced. The Conglomerate is extraordinarily thick, and the whole measurement of Pocono (upper and lower) is somewhat augmented. The 76′ red band seems to be the equivalent of the 40′ or the 27′ and 40′ red bands at Snydersburg, while the lower reds are not shown at that place. The measures included between the 27′ red band and the 11′ sand rock seem to represent the oil sand group at Snydersburg.

The Kinzua section is introduced to show the thinning away of the Pocono reds beyond the oil sand shore line. All the measures underlying the 27′ band of shale at Kinzua certainly belong to the Chemung.

The Mauch Chunk red shale at Snydersburg sufficiently defines the horizon of No. XI at that place. Its place is also indicated at Sligo; and the 72′ shale interval in the Smith well, corresponding to the space between the Ohio or Sharon conglomerate and the Shenango sandstone, seems to me to fairly represent the horizon of that formation in the western counties.

The thick red bands shown in the New Castle section and Smith well record are presumably synchronous and probably represent the Bedford shale of Ohio. This seems to find only a faint prolongation in the 5′ red band at Sligo, for the 26′ red band occurs *beneath* the First oil sand whereas the 60′ red of the Smith well overlies the First sand.

The Oil-sand group is seemingly absent from the New Castle record, the sands noted being gray fine-grained rocks of Chemung character; but a typical development of the oil

sand group is denoted by the Smith record (though the sands were non-productive.)

The Oil-sand group is not well shown by the Sligo record as that well was "off the belt," *i. e.* to one side of the productive area.

At the bottom of the plate a profile section has been inserted to show more clearly how I conceive the Catskill and also the Pocono red bands lie upon the Chemung shales; how the Catskill feathers out to a knife edge at a point uncertainly located somewhat east of Cameron; the Pocono Lower sandstones change gradually from gray to red; how the Oil-sands are synchronous with them and shore upon a Chemung encarpment allowing only the uppermost red band to reach west to the Ohio line.

This section also shows the Coal measures preserved from erosion in the synclinal troughs; the sporadic lenticular masses of Mauch Chunk red shale (XI); and the continuity of the Conglomerate measures from Queens's run to Ohio.*

A skeleton map is added to show the relative location of the principal places referred to in the above description.

*This section was constructed along two lines; one from Queen's run to Wilcox, the other from Butler county to New Castle.

Chapter X.

Vertical Sections in Series from the Allegheny Mountains to Ohio.

The following sections include those used in the construction of Plate IX, but some of them were for obvious reasons omitted from that diagram.

The sections from Lock Haven to Ridgway (inclusive) were compiled especially for this report; those west of Ridgeway are taken partly from work done in the McKean and Venango Oil districts and partly from my Clarion and Butler county and Beaver River surveys.

In many of these sections it is evidently impossible to fix an exact boundary line of division between the two sub-divisions of the Pocono measures, and for this reason they have not been broken up in the text into their geological horizons, for these horizons could only be empirically fixed. It therefore seems better to allow each section to stand alone as an undivided whole which the reader may split into as many groups as he sees fit; the relative equivalents of which can readily be determined by consulting Plate IX.

1. Altoona Section.

At Altoona the formations from No. VIII up to the Coal measures (XIII) are finely exposed by cuttings along the Pennsylvania railroad. The following section was made at this point by Mr. Platt:

No. XIII.	Lower Productive Coal measures, ...	345′ 4″
No. XII.	Coal measure Conglomerate; hard massive white and gray sandstones with interbedded coal, iron ore, shale, etc., ...	223 1′

(121 G^4.)

No. XI. Mauch Chunk Red Shale, containing some sandstone, ... *283′
No. X. Pocono sandstone; hard massive gray SS., some red beds, ... 1274′ 4″
No. IX. Red Catskill; red and gray sandstone and shale, 2560′
No. VIII. Chemung; Portage, Hamilton, Upper Helderburg, ... 6519′ 2″

The detailed section, as printed in Appendix A, to Report F, is as follows:

Detailed Section.

Mahoning sandstone.
2′ 8″ Coal bed.
20′ Drab slates.
5′ Olive shales.
10′ Massive slates.
20′ Olive slates and shales.
5′ 6″ Coal bed E.
2′ Impure fire-clay.
20′ Sandstone and black slate.
3′ Limestone.
20′ Ferruginous slates and shales.
20′ Sandstone and sandy shales.
3′ Coal bed D¹.
1′ Fire-clay.
21′ Sandstone, drab.
20′ Black slate.
2′ 10″ Coal bed D.
11′ Drab slates holding ore balls.
0′ 7″ Sandstone.
13′ Blue slates.
15′ Sandstone, massive, drab.
12′ 6″ Slate.
6″ Coal. } Bed C.
6″ Slate. }
1′ 8″ Coal. }
6′ Fire-clay.
12′ Sandstone.
1′ 3″ Slate.
0′ 4″ Coal.
7′ Sandstone.
8′ 10″ Black slates, with calamites.
3′ 6″ Coal bed B.
3′ Fire-clay.
29′ Shales.
2′ Black slate.
1′ 8″ Coal bed A¹.
23′ Slates.
4′ sandstone, gray.
4′ Coal bed A.
9′ Fire-clay.
XIII. Total, ... 345′ 4″
14′ SS., coarse-grained iron stained.
0′ 1″ Coal.
9′ Fire-clay.
4′ Slaty sandstone.
15′ Fine-grained grayish-white SS.
81′ Massive white sandstone.
100′ Concealed.
XII. Total, ... 223′ 1″
110′ Red shale.
40′ Gray slate.
5′ Red shale.
12′ Gray slate.
2′ Red slate.
4′ Fine-grained sandstone.
6′ Red slate.
4′ Greenish-gray slate.
6′ Red shale.
2′ Gray slate.
52′ White and grayish-white coarse-grained sandstone.
10′ Gray slate.
5′ Red slate.
10′ Gray sandstone.
10′ Red shale.
XI. Total, ... 283
2′ Gray shale.
200′ Gray sandstone.

*At the base of No. XI there is a mass of gray sandstone with some gray slate and red shale, in all 92 feet thick, of which but 15 feet is red. I am inclined to think that this is the upper part of No. X, and that it should be so placed, increasing the Pocono to 1366 feet and decreasing No. XI to 191 feet.
H. M. C.

3′ Red shale.
334′ Massive gray sandstone.
20′ Dark gray slates.
266′ Massive gray sandstone.
15′ Olive-gray sandstone.
20′ Red shale.
60′ Gray sandstone.
40′ Gray slate.
30′ Gray sandstone.
5′ Greenish-gray slate.
2′ Gray sandstone.
10′ Gray slate.
15′ Massive gray sandstone.
5′ Brown shale.
20′ Red shale and slate.
15′ Brown sandstone.
5 Gray slate.
20′ Red shale and slate.
20′ Massive gray sandstone.
29′ Red shale.
11′ Gray sandstone.
10′ Gray slaty sandstone.
17′ Brown slaty sandstone.
10′ Red shale.
1′ Gray micaceous sandstone.
1′ Iron ore, greenish-gray.
0′ 1½″ Gray micaceous sandstone.
1′ 9″ Iron ore, greenish-gray.
26′ Massive gray sandstone.
5′ Red slate.
1′ 6″ Iron ore, greenish-gray.
14′ Gray micaceous thin bedded SS.
1′ Ferruginous sandstone.
38′ Gray sandstone.
7′ Gray slate.
3′ Red slate.
1′ Brown sandstone.
2′ Red slate.
15′ Gray slate.
16′ Gray sandstone.
5′ Red shale.
7′ Red slate.
45′ Gray sandstone.***

X. Total, ... 1,274′ 4″

9′ Red shale.
3′ Gray shale.
15′ Red shale.
12′ Brown sandstone.
25′ Red shale.
20′ Gray sandstone.
25′ Red shale.
196′ Concealed.
Red sandstone.
167′ Concealed.
30, Brown shale.
50′ Brown sandstone.
35′ Red shale with three small layers of olive shals.
30′ Brownish-gray sandstone.
10′ Gray slaty sandstone.
30′ Reddish-brown sandstone,
3′ Red shale.
20′ + Yellowish-gray sandstone.
264′ Concealed and reddish sandstone and slate.
6′ Gray shals.
50′ Red shale and sandstone.
10′ Gray slaty sandstone.
265′ Red shals and sandstone.
20′ Red sandstone.
10′ Red shals.
15′ Red sandstone.
15′ Red shale and sandstone.
15′ Red sandstone.
80′ Red shals.
305′ Concealed.
15′ Gray shals.
14′ Red SS., with some gray shale.
10′ Red shale.
10′ Red and gray shale.
2′ Gray shals.
4′ Red sandstone.
15′ Red slate with some gray SS.
20′ Gray shale.
70′ Red shals.
5′ Gray sandstone.
40′ Red shale.
15′ Reddish-brown sandstone.
60′ Red shale with layers of gray sandstone.
25′ Gray sandstone with red shale; small layers of gray shale.
40′ Gray sandstone and slate.
480′ Concealed.

IX. Total, ... 2560′.

*** Near this occurs Edward Miller's Silicious Limestone 30′ thick, at the foot of Plane No. 7 of the Old Portage Railroad. See Trans. Geol. Soc. Penn'a, vol. I, page 253.

20′ Red slate with gray sandstone, mostly sandstone.
40′ Gray slates.
20′ Gray sandstone.
3′ Gray slate.
20′ Gray sandstone.
40′ Gray slate.
90′ Gray sandstone and slate, with a slight reddish tinge.
40′ Gray sandstone and slate.
410′ Concealed.
192′ Gray slate.
8′ Gray sandstone.
10′ Light gray slate.
1′ Gray sandstone.
8′ Dark gray slates.
10′ Gray sandstone.
86′ Dark gray slates and concealed.
15′ Dark gray slates.
1 Gray sandstone.
50′ Gray slates.
2′ Gray sandstone.
4′ Gray slate.
10′ Gray sandstone.
0′ 2″ Gray slate.
1′ Gray sandstone.
70′ Gray slate.
300′ Concealed.
20′ Gray slate.
260′ Slaty sandstone.
20′ Gray shale.
30′ Gray sandstone and slates, thin bedded.
505′ Concealed.
50′ Gray sandstone thin bedded with slate.
460′ Gray slate with thin layers of gray sandstone.
50′ Gray slate.
50′ Concealed.
35′ Gray slate with a few layers of gray sandstone.
50′ Gray slate, cleavage planes iron stained.
780′ Concealed, mostly gray slates.
185′ Olive and gray slates with 10′ red slates.
5′ Red slates.
418′ Gray slate and sandstone.
75′ Slaty sandstone and gray slate.
10′ Gray sandstone.
100′ Gray slates, some of the slates have ripple marks.
600′ Gray slaty sandstone, thin.
1365′ Gray and black slates, the black slates are the lowest. Thickness not known.

VIII. Total, ... 6519′ 2″

2. *The Lock Haven Long Section.*

This section embraces a description of the formations from the top of the Hudson river slates, No. III, up to the Lower Productive Coal measures.

The rocks from No. III to No. VII were measured at Mill Hall Gap, and from No. VII to No. XIII on the Susquehanna river between Lock Haven and Farrandsville. The total thickness of the strata described is 13,636+ feet, which may be divided by the Pennsylvania numbers, as follows:

Carboniferous 215′+	No. XIII. Lower Productive Coal Measures,	86′+
	No. XII. Conglomerate Measures,	129′
Sub-carboniferous 1275′	No. XI. Mauch Chunk red shale (local),	*100′
	No. X. Pocono Sandstone; upper and lower,	1175′

* This red shale is local, disappearing in half a mile, its place being occupied by sandstone and conglomerate belonging to No. XII.

Devonian 7870′	No. IX.	Red Catskill,	2106′
	No. VIII.	Chemung and Portage,	3314′
		Genesee,	560′
		Hamilton,	1131′
		Marcellus,	759′
			5764′
	No. VII.	Oriskany Sandstone—wanting—	—
Upper Silurian 1975′	No. VI.	Lower Helderburg and Water-line,	895′±
	No. V.	Clinton red shales; with fossil ore,	1080′
Middle Silurian 2301′	No. IV.	Medina and Oneida Sandstones,	2301′
Lower Silurian.	No. III.	Hudson river and Utica Slates, not measured.	
	No. II and I.	Lower Silurian Limestones and Potsdam S. S., not measured.	

Detailed Section.

Lower Productive Coal Measures. XIII.

Surface,	35′
Coal; variable 3′, to 4′, upper bed,	3′
Fire-clay; used for fire-brick,	5′
—— Concealed, Shale and Sandstone,	40′
Coal; middle bed,	3′
Total,	86′

Pottsville Conglomerate. XII.

S. S. and Shale,	40′
Coal; lower bed, 2′ 0″ to 3′ 6′,	2′
Fire-clay; 6 to 8 ft., used for fire-brick,	7′
—— Concealed. Some Sandstone,	80′
Total,	129′

Mauch Chunk Red Shale. XI.

—— Concealed; trace of red shale,	20′
Red and olive shale. This red shale is only a local deposit,	20′
—— Concealed,	55′
Red shale,	5′
Total,	100′

Pocono Sandstone. X.

S. S. white and gray, rather coarse,	15′
Limestone and S. S. in one massive bed. The limestone lies in layers or lenticular patches, ¼ to 1 inch thick. In some parts of the rock it lies in nodules resembling pebbles, and giving the rock the appearance of being a conglomerate. The lime is pure, and free from any admixture of sand,	3′
S. S. gray and greenish gray, false bedded,	25′
—— Concealed,	10′
S. S. gray. Some thin-bedded layers, only partially exposed,	70′
—— Concealed; contains a band of red shale,	60′
S. S. hard, gray; contains a layer of cannel slate, 2′ to 3″ thick,	80′

—— Concealed,	65′
S. S. gray, hard and massive,	5′
—— Concealed,	40′
S. S. hard gray,	35′
S. S. coarse gray, with a pebble layer 12″ thick near middle,	15′
S. S. coarse gray, with a pebble layer 12″ thick at base,	10′
Red Shale; soft,	20′
S. S. and Shale alternating; S. S. is hard and gray,	68′
S. S. gray and hard, massive,	47′
S. S. thin-bedded, greenish gray, alternating with shale,	59′
Red shale,	5′
Olive shale,	8′
Red shale,	3′
S. S. thin-bedded, alternating with olive shale and dark slate,	41′
Principally shale, few bands red shale,	71′
S. S. hard, greenish gray, upper part streaked with red,	45′
Olive shale, some sandy bands,	20′
S. S. hard gray,	20′
—— Concealed softer S. S. and shale,	285′
S. S. gray, reddish gray, and greenish gray, beds parted by shale,	50′
Total,	1,175′

Catskill. IX.

Red shale,	10′
S. S., very hard, massive, gray, reddish, and greenish gray, some red,	95′
S. S., Greenish gray, with red and olive shale partings,	30′
Red shale; soft,	53′
Red S. S., hard and massive, micaceous, with one thin band red shale,	20′
Red shale, one band massive red S. S. partly concealed,	131′
Red and greenish gray S. S., massive and hard,	30′
Red shale; partly concealed,	56′
S. S. red and grayish red,	32′
—— Concealed; principally red shale, with S. S.,	73′
S. S. red and greenish gray, massive,	20′
Red and olive shale,	19′
Red Conglomerate Fish bed. Pebbles of S. S. and limestone (?) irregular. Full of iron concretions,	2′ 4″
Red shale; few bands of red S. S.	31′
S. S. massive red and greenish gray,	4′
Red shale; soft, with a few sandy bands,	131′
Red S. S. massive, parted into sub-divisions by two or three bands red shale 5 to 10 feet thick,	148′
Red S. S. and shale, alternating very regularly in bands from 5 to 10 feet thick. The S. S. is massive and the shale soft. Complete exposure,	985′
Red Shale and Red S. S. alternating, with a few bands of gray S. S. streaked with red,	235′
Total,	2,106′

Chemung, Portage. VIII.

Olive slate,	20′
Shale; olive and gray alternating in thin bands with gray S. S.,	217′

—— Concealed, contains some gray slaty shale, and gray S. S.,	110′
Olive shales and gray slates with two bands purplish red slate,	134′
Red shaly S. S.	9′
Olive shales and gray and purplish red slate, some sandy layers,	38′
S. S. massive gray,	20′
S. S. hard gray alternating with slates and shales,	51′
Slates and shales; soft, dark, with a little reddish slaty shale,	77′
S. S. hard gray, massive,	13′
Slates and shales; soft olive, gray and purplish red,	57′
S. S. massive red,	2′
S. S. hard gray,	4′
Purplish red slate and shale with some reddish and gray S. S.	83′
S. S. and shale (gray) alternating,	9′
Red S. S. and shale,	41′
S. S. massive,	2′
Shale and slate, dark and soft,	18′
S. S. massive gray,	4′
Shales; olive and gray, soft,	37′
S. S. massive gray,	5′
S. S. hard gray, alternating with dark slates and shales,	36′
S. S. massive dark gray,	10′
S. S. hard gray with slate partings,	39′
S. S. massive gray,	6′
S. S. gray and dark slate alternating,	12′
Shales and slate alternating with bands of hard gray S. S.	125′
Slate; soft dark,	5′
S. S. hard gray,	11′
Shales; gray and olive with dark slates and a few bands of gray S. S. near middle of the mass,	88′
S. S. gray, alternating with gray slaty shale,	57′
Purplish red and gray slaty shale,	12′
S. S. hard gray, some greenish slaty shale partings,	30′
S. S. massive light gray,	13′
Slates and shales, purplish red, olive and gray. Red predominates near base,	77′
S. S. [gray] slates and shales alternating,	92′
Red and gray shales, soft,	69′
Red and reddish gray S. S.; shale partings,	9′
Slates and shales; red, olive, and gray—soft with some sandy bands,	22′
S. S. gray, with red slate and gray shale partings,	57′
Red and reddish gray S. S. with purplish red slates and shale,	22′
Purple shaly slate,	6′
S. S. thin bedded, alternating with slate,	15′
Slates; soft gray with some shale,	53′
Gray S. S. gray shale, and dark slate alternating,	84′
Shale, dark gray and olive, with two thin bands of S. S.,	53′
S. S. gray thin bedded, slate and shale alternating,	17′
Shale; soft olive and gray ferruginous,	7′
S. S. fine grained bluish gray, parted by dark slates,	15′
Shale; very soft olive,	39′
Purplish red slate shale,	4′
—— Concealed,	303′

Slaty shale; gray and sandy,	15′
Slates and shales alternating with thin bands of very dark S. S.,	70′
Slates; dark, with two thin bands of S. S.,	30′
Olive shales and dark blue slates,	78′
S. S. dark gray, alternating in bands 6″ to 12″ thick with dark bluish shale,	63′
Shale; soft olive with a few thin bands of S. S.,	172′
S. S. hard massive gray,	7′
Olive shale, soft,	21′
S. S. gray, hard and massive,	4′
Olive shales, soft; slaty near bottom,	128′
Soft shales, not well exposed,	183′
Slate; soft bluish black,	15′
S. S. gray alternating with dark gray slates and olive shales,	189′
Total,	3,314′

Genesee. VIII.

Soft dark gray and olive slates, some bands of slate,	560′

Hamilton flags. VIII.

S. S. thin bedded dark gray, alternating with olive and gray shaly slate,	110′
Slate; bluish gray and blue, with some olive shale and an occasional band of S. S.,	225′
Soft shaly and slaty measures not well exposed,	127′
S. S. thin and flaggy with some slaty shale,	248′
Shale and slate, not well exposed,	176′
S. S. dark; thin beds, some shale and some thick beds blue sandy slate,	245′
Total,	1,131′

Marcellus black shale. VIII.

Shales; soft with some thin flags not well exposed,	96′
Slate, shaly with some thin sand bands,	68′
Slate, very dark,	68′
Slate; dark blue and black, soft,	158′
Slate; dark, some few thin bands gray S. S.,	45′
Slate; soft black and dark gray,	324′
Total,	759′
[Total, VIII. Chemung, Portage, Genesee, Hamilton and Marcellus, 5,764′.]	

Oriskany. VII. Wanting at Lock Haven.

Lower Helderberg Limestone. VI.

Limestone, massive, impure, shaly on top,	80′
Lime shale and impure limestone,	83′
Soft dark bluish black slates, upper part calcareous,	177′
Limestone, shaly and massive,	30′
Concealed in Valley of Susquehanna. [Limestone?]	+500′
Limestone massive, quarried,	25′
Total,	895′

Clinton. V.

Nearly all concealed at Mill Hall Gap, shales, slates and sandstones containing the "fossil" and "block" iron ores, both of which have been mined by Mill Hall Furnace Co. The fossil ore is here about 10" to 12' thick,	1,080'

Medina and Oneida S. S. IV.

S. S. hard and massive, red, gray, and white; not well exposed,	695'
Softer S. S. and shale, forming the valley between the two crests of the mountain,	705'
S. S. hard and massive; white with a few beds of gray S. S. mottled with ferric oxide,	183'
——Concealed; probably softer S. S. and shale with some red bands,	118'
S. S. hard, massive, siliceous, dark gray and greenish gray, iron specked,	155'
Not well exposed, principally hard, massive S. S.,	440'
Total,	2,301'

3. *Farrandsville Switch-back Section.*

This was compiled from exposures along the switches of the abandoned Eagleton railroad. A similar, but less perfect, section was made near the Rock Cabin mines. Both of these sections fail to show any red rock at the horizon of the Mauch Chunk red shale. The Conglomerate sandstones crop out in bold cliffs at many places along the Tangascootack gorges, but their exposures are so disconnected, that it is very difficult to obtain accurate measurements of the whole mass. The switch-back section is as follows:

50±	Concealed in Summit; S. S. and shale with one coal bed.
40	S. S. coarse, hard and white. Top of No. XII.
41'	Concealed; contains one coal bed in upper part.
10'	S. S. greenish gray, usually hard, with olive shale partings.
8'	Concealed.
3'	S. S. hard, gray, and ironstained. Olive shale partings.
2'	Conglomerate, discolored with ferric oxide. [Bottom of XII?] Pebbles from various kinds of rock.
47'	Concealed.
20'	S. S. flaggy, gray and hard, streaked with iron.
15'	S. S. grayish, iron stained.
26'	Concealed.
10'	S. S. Coarse, hard, and discolored. [Bottom of XII?]
57'	Concealed.
5'	S. S. massive grayish; laminated structure.
10'	S. S. massive gray, silicious, flaggy at top.
8'	Concealed.

15′ S. S. hard and gray.
16′ Concealed.
5′ S. S. massive, ironstained.
10′ S. S. coarse and fine grained alternating.
75′ Concealed.
10′ S. S. laminated, greenish gray.
15′ S. S. gray, hard coarse and massive.
15′ Concealed.
5′ S. S. hard, greenish gray, sometimes massive.
15′ Concealed.
3′ S. S. coarse and hard, yellowish gray.
85′ Concealed to river level at mouth of Tangascootack creek.

Total thickness 621 feet of which probably 222 feet belong to the Conglomerate measures. The horizon of the Lower Pocono is below water level at this point.

4. Furney's Run.

No trustworthy section can be obtained at Furney's, as the hillsides are covered with detritus from the Conglomerate sandstones and underlying flags, which effectually hide all outcroppings of the Sub-carboniferous rocks.

The Pocono measures are throughout, harder and more massive than at Hyner's, but not so hard nor so coarse as at Queen's run. The Lower Pocono here, as at Queen's run, contains but few red bands and these are probably quite thin.

The rocks of the Conglomerate series furnish exposures similar to those at Wetham and Glen Union. One of its members is locally a true conglomerate, containing rounded pebbles from one third to three fourths of an inch in diameter.

5. Wetham Section.

At Wetham the Conglomerate sandrocks are better exposed than any of the underlying rocks. They lie in the hill-tops, often jutting out in shelf-like cliffs. Nearly all the small ravines (known by the name "drafts") terminate at springs issuing from the base of the Conglomerate.

The summits in this neighborhood are 950± feet above the railroad or 1525± feet above tide.

The following section, though rather incomplete, is as good an one as could obtain.

70′	Concealed; soft and sandy with one coal bed.
30′	S. S. white, conglomeratic, coarse and hard.
20′	Concealed.
50′	S. S. Coarse, and loose grained; some conglomeratic layers.
100′	Concealed.
20′	S. S. Coarse and hard; nearly white, [Base of No. XII.]
400′	Concealed; principally hard gray sandstone, [Gray Pocono.]
15′	Red and gray sandy shales.
160′	Soft sandy shales with a few bands of hard sandstone.
6′	Red and gray sandstone, hard.
50′	Concealed to R. R. level.

6. *Hyner Section.*

Hyner's Run Oil Well Section, annexed to a detailed section of the rocks in the vicinity of Renovo.*

The order of the Coal Rocks of this section was determined by Mr. C. A. Ashburner, from a survey made near Renovo, in 1875. The lower part of the section is taken from the record [kept by Jas. David, Esq.] of a well drilled for oil near Hyner Station on the P. and E. R. R. The remainder of the section is supplied from a generalization of several intermediate sections of the surface exposures between Renovo and Hyner, and may be taken as a description of the rocks at any point between those two places.

The total thickness of the measures described amounts to 3,460 feet, grouped as follows:

212′ 4″	*Lower Productive Coal Measures:* S. S. shale, fireclays, etc., with four (4) workable beds of coal.
245′	*Conglomerate, or Beaver River Group, (No. XII;)* Massive S. S. parted by shale and thin-bedded S. S. The S. S. of this group are white to yellowish white or gray in color, massive, hard, and coarse-grained, making prominent topographical features.
390′	*Gray Pocono;* Greenish gray thin-bedded sandstones, generally fine grained, with some brownish mottled sandstones, and some micaceous beds, separated by softer measures,—shales or slates,—with an occasional red band.

* Rewritten from Proceedings of the American Philosophical Society, May 3, 1878.

600′ *Red Pocono:* Gray and greenish gray sandstones, laminated and fine grained, with an occasional bed of red sandstone, and a large percentage of micaceous beds, alternating with red and olive shales. Red color is very prominent in soil.

826′ *Catskill red rocks,* (*IX;*) Red Sandstone and shale, with some bands of gray sandstones, and shale.

1,187′ *Chemung,* (*VIII;*) Slates and shales, bluish in color, alternating with dark sandy bands, to bottom of well.

3,460′ 4″ Total thickness of rocks described in section.

Detailed Section.

Lower Productive Coal Measures. XIII.

Concealed,	15′
Coal, [No. 5 of Mr. Ashburner's provisional numbers,]	4′
Concealed,	92′
Coal, [No. 4,]	3′ 2″
Fire-clay and "kidney ore,"	10′
Shale and shaly S. S.,	15′
S. S. coarse-grained,	26′
Concealed,	4′
Coal, [No. 3,]	4′
Concealed,	26′
S. S. gray,	10′
Coal, [No. 2,]	3′ 2″
Total,	212′ 4″

Conglomerate, (*No. XII.*)

S. S. gray, hard, "upper part S. S., lower part shale,"	33′
Coal, [No. 1,]	1′
Conglomerate,	25′
Concealed. Mr. Ashburner states that some red shale has been found in this interval,	41′
S. S. hard, gray, coarse-grained,	25′
S. S. white and gray, thin bedded, with some shale,	40′
S. S. hard, very dark, gray,	20′
Concealed,	25′
S. S. coarse and loose grained, gray,	35′
Total,	245′

Gray Pocono.

Concealed; trace of red, [No. XI?]	65′
S. S. hard, thin bedded, grayish steel color,	25′
S. S. brownish, fine grained, micaceous, with shale, and braces of red; poorly exposed,	50′
S. S. fine grained, greenish gray,	20′
S. S. very fine grained, laminated, gray,	20′
Shale; with micaceous brownish sands—poorly exposed—trace of red,	45′

S. S. mottled, brownish, micaceous and flaggy, in two members, parted by shale,	75′
Shale; with some fine grained greenish gray S. S.,	90′
Total,	390

Red Pocono.

S. S. and shale, red and olive, fine grained, micaceous,	20
S. S. greenish gray, with shale,	70
S. S. fine grained, red and gray, alternating with shale,	175
S. S. red with some interbedded gray,	25
S. S. greenish gray,	15′
S. S. red,	20′
Concealed,	35′
S. S. greenish gray, hard; some red bands,	30′
Concealed,	20′
Shale and red S. S.,	10′
Concealed,	10′
S. S. fine grained greenish gray,	10′
Concealed,	20′
S. S. fine grained greenish gray,	10′
Concealed,	10′
S. S. red, nearly all fine grained and shaly,	30′
Concealed,	30′
S. S. hard, dark gray, mottled with brown,	5′
Concealed,	25′
Shale and S. S. red,	30′
Total,	600′

Catskill red rocks. No. IX.

Concealed; above well mouth,	30′
Drive pipe in well, "Stone and wash," "Local Drift,"	50′
Red rock; with iron,	30′
Gray rock; hard and dark,	15′
Red rock; partly shales,	22′
Gray rock; with mica,	16′
Red rock; hard,	5′
Red rock; salt water,	32′
"Copper" (?) rock,	4′
Red rock; salt water,	10′
Gray rock; salt water,	16′
Red S. S.; gas,	46′
Red rock; with shales—gas,	52′
Gray rock; very hard,	11′
Red rock, with gray shales,	115′
S. S.,	4′
Red S. S.,	111′
Gray rock,	8′
Sandy red shale, gas,	37′
Gray rock; dark, some sandy bands,	95′

Red rock; some oil,	35′
Shale; sandy and gray, "partially hard,"	35′
Red shale; some ore,	10′
Gray rock, with sand,	30′
Red shale,	7′
Total,	826′

Chemung.

Shale and S. S. alternating, blue,	67′
S. S. fine and white,	25′
Slate, blue,	38′
S. S. and blue slate, alternating,	96′
S. S. white,	6′
S. S. blue, very hard,	55′
S. S. and shale, blue and very hard,	92′
S. S. and shale, blue,	30′
S. S. brown and white; oil and gas,	5′
S. S. dark blue, with shale,	165′
S. S. dark blue, with white sand shells,	10′
Sand shale; soft and blue,	33′
Shale; blue, with brown and black sand shells,	125′
Shale; soft blue,	150′
S. S. white with oil,	46′
Shale; sandy, blue,	25′
Sandy shelly rock, blue,	219′
Total to bottom of well,	1187′

7. *Keating Section.*

From Shintown Run to Keating the river valley nearly coincides with the strike, or line of no dip, and there is consequently but little Red Pocono above water level in this part of the valley.

At Keating the top of the Red Pocono lies very near water level. One half mile above the station the Upper Pocono is finely exposed.

The following section of 755 feet was compiled from measurements made in the immediate vicinity of the station.

The base of No. XII is either at the 10′ coarse white sandrock, or at the 15′ coarse conglomeratic rock.

30′ Sandy and shaly, not well exposed.
15′ S. S. hard grayish white.
15′ Shale; with one coal bed, fire-clay floor.
30′ S. S. in two members, coarse and white.
135′ Sandy, not well exposed.

10′ S. S. coarse, white. [Base of No. XII?]
70′ S. S. gray and white near middle, remainder concealed.
15′ S. S. coarse white, thin bed of conglomerate. [Base of XII?]
10′ S. S. thin bedded, gray.
20′ S. S. massive, gray.
35′ Concealed,—sandy.
30′ S. S. shaly, dark gray, with some sandy shale.
25′ S. S. hard, rather coarse, dark gray, and reddish gray, iron specked.
25′ Concealed, (gray S. S.?)
40′ Partly concealed. Shale, sandy, red, [with an ore band,] and olive.
20′ S. S. thin bedded, greenish gray.
60′ S. S. hard, compact, massive, gray.
20′ S. S. hard, gray.
25′ S. S. hard, gray, iron specked,—trace of red shale.
25′ S. S. red, shaly, with shale and gray S. S. [Top of Red Pocono?]
15′ S. S. very massive and hard, gray.
40′ Concealed, principally sandy.
10′ S. S. flaggy.
15′ S. S. hard, greenish gray.
5′ Shale, gray.
15′ Red shale and S. S. to river level.

8. Sinnemahoning Section.

From Wistar to Sinnemahoning the rocks rise more than 300 feet, bringing a great part of the Lower (red) Pocono above water level, and throwing the Conglomerate sandrocks into the highest knobs at Sinnemahoning. The exposures in this vicinity are not good, and the following section of 1,112 feet was compiled mainly from surface indications and disconnected outcrops. Though quite faulty in its details, it shows the general features of the formations in the neighborhood of Sinnemahoning.

15′ S. S. hard, coarse, white, iron-stained, on Summit 1,090′ above R. R.
20′ Concealed, softer sandy measures.
50′ S. S. and Conglomerate white,—pebbles size of hazel nut.
55′ Softer measures with iron ore.
25′ S. S. thin bedded, yellowish, gray.
35′ S. S. white, but iron stained, [base No. XII?]
40′ S. S. fine grained gray micaceous.
15′ Shales, gray.
5′ Red and olive sandy shale.
5′ Sandy gray shale, laminated and micaceous.

2′ Red shale, [ore bed.]
10′ S. S. thin bedded and fine grained, gray.
60′ S. S. massive, laminated, fine grained; in cliffs.
140′ Principally gray shale, some sandy beds, trace of red; gray S. S. at base.
60′ S. S. hard, gray and greenish gray, part concealed.
20′ Concealed.
60′ S. S. hard and gray.
30′ Concealed.
70′ S. S. fine grained, hard, gray, with a few red bands.
40′ Concealed, soft measures.
20′ S. S. fine grained, gray.
25′ S. S. red, mottled, and grayish red, with some shale.
35′ S. S. fine grained, gray.
85′ S. S. red and gray, alternating.
100′ S. S. and Shale, red and gray,—red predominates.
50′ S. S. gray, some red,—poorly exposed.
20′ S. S. and shale, red.
20′ S. S. and shale, red.

9. Sterling Section.

From the Second Anticlinal axis at Driftwood, there is a very sharp northwest dip into the Third Bituminous Coal Basin at Cameron. At Sterling, which is but four miles from Cameron, much of the Red Pocono is below water level, while at the Cameron Coal-banks it lies entirely beneath the creek.

The following section of 1,040 feet was compiled at Sterling, from disconnected outcrops and surface indications. At many places on the hillsides where there is no actual outcropping of the strata, their character can be determined with a fair degree of accuracy, for as there are but few rolled pieces of rock, and the debris of broken stone are nearly in place, and the fragments of one layer are not much mixed with those from that above it, every change in the character of the underlying rock can be immediately detected by the surface detritus. In some places these changes are so distinctly marked upon the surface that they give the mountains a banded appearance, which is often noticeable sometimes at a distance of two or three miles.

50′ Shale with bands of S. S. Summit 1,031′ above R. R.
40′ S. S. hard, white and massive, iron stained.
45′ Softer measures.

35′ S. S. hard, gray.
25′ S. S. hard, grayish white, fine grained.
70′ S. S. soft thin bedded, shaly, with some shale.
40′ S. S. coarse gray iron stained.
125′ Principally gray thin bedded S. S. and shale, thin red band near middle.
125′ Principally gray thin bedded S. S. and shale, no actual exposures.
25′ Shale; red and olive.
25′ S. S. shaly, gray, with shale.
20′ Shale; sandy, with some thin bedded S. S.
70′ S. S. hard, thin bedded gray, with some sandy shale.
20′ S. S. gray, and Shale, with trace of red, [good farming land up to this point.]
70′ S. S. gray, and shale, (some red?)
30′ S. S. red and gray.
30′ S. S. gray and greenish gray.
170′ Red Shale and Red S. S. with some gray S. S.
25′ Shale; red and gray with some S. S. to R. R. level.

10. Cameron Section.

At the Cameron inclined coal plane the Conglomerate and Coal Measure rocks, are brought very low by the Third Synclinal axis. The Red Pocono is entirely beneath water level at the plane, but near Cameron Station its upper layers are exposed near stream level. The Cameron Well record shows that this group of measures is 339 feet thick, with Chemung Measures immediately underlying it. The Red Catskill is therefore seemingly absent.

The lowest coal discovered by the coal company lies about 490 feet above the well mouth. It is underlaid by 30 feet of hard coarse sandstone, and this in turn, by 180 feet of sandy measures in which some very hard massive, coarse-grained sandstones occur, and which I have considered to contain the lower layer of No. XII.

The vertical section is as follows:

3′ "Mount Hope Coal."
80′ Concealed;—sandy and slaty shale with Frog Hollow Coal Bed?
2′ "Twin seam" coal.
20′ Shale, sandy and slaty.
2′ "Star vein" coal.
15′ Concealed.
4′ Coal in prospecting holes.

20′ S. S. and shale, } 30 foot rock.
10′ S. S. hard gray and coarse, }
55′ Concealed.
125′ S. S. coarse and massive, in two—sometimes three—sub-divisions.
305′ Principally gray S. S. and shale, alternating to mouth of oil well.

Cameron Well.

Situated ½ mile above Cameron Station. Drilled in 1865-6. Authority, Cameron Coal Company.

Gray flag, first rock,	113 to 113
Chocolate, (*red,*)	8 to 121
Blue,	59 to 180
Chocolate, (*red,*)	41 to 221
Blue,	14 to 235
Chocolate, (*red,*)	24 to 259
Blue,	28 to 287
Chocolate, (*red,*)	104 to 391
Gray,	34 to 425
Chocolate, (*Red,*) [base red Pocono,]	35 to 460
Gray,	120 to 580
Dark iron gray,	9 to 589
Light gray,	37 to 626
Iron gray,	37 to 663
Light gray, rock hard, gas increasing,	84 to 747
Yellowish, very sharp grit,	42 to 789
Light gray, large quantities of gas, rock not very hard,	21 to 810
Blue, soft, shelly, growing harder and whiter, then changed to a brown rock, showing a fresh color, thence to blue,	64 to 874
Growing whiter,	20 to 894
Red, (Chemung,)	4 to 898
Blue, rock very hard,	73 to 971

No oil. Total depth of well, 971 feet.

NOTE.—Though this is an old well, and was drilled as a "wet hole," [i. e. no casing was used to shut off the water,] the record within certain limits may be relied upon, for

1st, There was little probability of error in fixing the top of the red rock, for it was first struck at a comparatively shallow depth.

2d, The base of the red measures at 460 feet is corroborated by the Emporium section.

3d, The absence of red from the underlying rocks can be accepted, for if any was present it would surely have been detected, even though the well was drilled wet and little red is seen in these rocks at Emporium.

11. Emporium Section.

Emporium Junction is but four miles north by west from Cameron, yet in this distance the rocks rise about 620 feet,

for at Cameron—which is 57 feet below Emporium Junction *—the base of the red Pocono is 460 feet more or less *beneath* railroad level, while at the Junction it is more than 100 feet above the railroad—460′+100′ +57′=617 feet.

On the hill south of the Junction a few feet of the soft red shale of XI caps the summit; the lowest member of No. XII has therefore just been removed from the hilltop by erosion. This summit is 890 feet± above railroad level, which height may be taken as the elevation of No. XII at this point—890′—617′ (the rise from Cameron)=273 feet as the elevation above Cameron at which the base of No. XII should be found. The Cameron section shows about 280 feet. These calculations are necessarily more or less inaccurate, as the elevations used were obtained by barometric readings; but they approximate the truth closely enough to show that the error in the horizon of No. XII at Cameron must be very small.

The small patch of Mauch Chunk red shale lying on top the hill near Emporium is quite variable in thickness. On the north side of the hill it is entirely absent, its horizon being apparently filled by Pocono sandstone, but this appearance may possibly be due to the sharp south dip pervading the rocks at this point.

The Conglomerate occurs in the hill one fourth of a mile farther south where it bluffs out in cliffs at a *lower level* than the exposure of red shale.

It is probable that in the following section, the thickness of the upper rocks has been somewhat exaggerated by the sharp southeast dip.

Summit below, just below XII.

175′ Soft shales, some red shale of XI near top, forming red soil.
75′ S. S. and shale, hard gray S. S., one band conglomeratic S. S. with scattered pebbles.
300′ Partly concealed, S. S. and soft gray shale.
210′ Gray S. S. and shale, with a few bands of red shale, [red vespertine.]
100′ Red shale, alternating with gray S. S. and shale.
10′ S. S. hard greenish gray; manganese specks.
25′ Red S. S. and shale.
15′ Sandy gray flags.

[* Report N., page 142.]

10′	Sandy gray flags overlaid by band of olive shale.	
8′	Red shale and S. S. with some olive.	
15′	S. S. thin bedded dark gray, shaly on top,	Chemung measures.
20′	Shaly slate; soft olive,	
50–75′	Concealed to mouth of well,	

12. Taylor and Eakin, Emporium Well.

In this well some thin bands of Chemung red rock were encountered at 250 feet. They were of the purplish hue characteristic of the Chemung red bands. As the well commenced drilling at about 100 feet or more beneath the Red Pocono, these red bands lie at least 350 feet beneath that formation and may (on account of the sharp dip) underlie it by 400 feet. In the Cameron well a thin red band is noted in the Chemung at a depth of 894 feet which is 434 feet beneath the lowest red band of the Red Pocono. It is quite probable therefore that these two red layers are identical. The first red horizon in the Chemung of the McKean county oil wells lies at about the same depth beneath the Red Pocono, and also shows this characteristic purplish hue.

I have examined an incomplete set of sand pumpings of the Taylor and Eakin well, with the following result. They were preserved in bottles labeled with the depth.

Labels.	*Description of Contents.*
"First 50 ft.,"	Fine dark gray shaly sand.
"100 ft.,"	Same; trace of dark slate.
"250 ft.,"	*Red shale;* some light gray S. S. and dark slate.
"255 ft.,"	S. S. fine grained, hard grayish white, micaceous mixed with some dark shale.
"265 ft.,"	*Red shale.*
"300 ft.,"	Fine grayish white, hard sand, and gray shale.
"310 ft.,"	Gray shale, and some fine grayish white sand.
"400 ft.,"	Bluish gray sandy shale.
"475 ft.,"	Dark slate and some dark fine S. S.
"516 ft.,"	Soft shale and fine sand, ground to a powder.

Total depth of well 1410 feet.

13. Emporium Well.

Drilled in 1878 on the Bond Farm, 4 miles northwest of

Emporium, Hughston, Ernst & Co., lessees. Authority: Mr. Hughston.

Record.

Conductor,	25 to 25
Shells,* mostly fine S. S.,	200 to 225
Red Rock,	12 to 237
Hard shells and "rubber rock,"	68 to 305
Hard shells,	40 to 345
Red Rock,	5 to 350
Shells and "rubber rock,"	75 to 425
Soft slate,	175 to 600
1st S. S. slight gas show,	55 to 655
Slate and shells,	295 to 950
2d S. S.,	70 to 1020
Hard shells and "rubber rock,"	55 to 1075
Pebble sand,	4 to 1079
Soft slate,	250 to 1329
Sand shells and slate mixed,	278 to 1607

Cased at 305′ with $5\frac{5}{8}$″ casing. Salt water at 320′. Cased smaller casing (?) 426′. Unproductive.

NOTE: This well also shows the Chemung red horizon. It probably commenced drilling at an horizon geologically level with the Taylor and Eakin Well mouth. It is given in the driller's nomenclature.

14. Rathbun.

From Emporium westward to St. Mary's there are but few exposures. The Conglomerate is caught in the hill-tops at Beechwood and Rathbun where coal has been found in its upper portion and immediately overlying it.

The Gray Pocono is very soft and presents no exposures except at creek level. The following section was compiled principally from surface indications:

50′	Sandy, not well exposed, on summits.
15′	Slate, blue.
—	Coal.
60′	Concealed;—contains beds of sandstone.
60′	Sandstone; hard and coarse.
115′	Concealed,—some hard coarse white S. S.
215′	Concealed,—soft measures, some sandy bands and one bed conglomeritic sandstone. (?)
60′	Shale,—soft, dark, and slaty to R. R. level.

*A shell is any hard stratum,—generally sandy.

The top layers of the Red Pocono are exposed in the creek bed a short distance below Rathbun.

At St. Mary's the Red Pocono is far beneath water level and only a very limited portion of the Gray Pocono can be seen. The Red Shale of No. XI may be seen in cuttings along the railroad but a short distance from West Creek Summit. The same stratum is again exposed on the railroad a short distance west of St. Mary's.

15. Ridgway Section.

This section was compiled from a series of surface exposures between the coal-bank,—which lies about two thirds of a mile north from town,—and the railroad station.

50′+	Shaly measures, in summit above coal, contains a massive friable sandstone.
3′	Coal (mined) Mercer group?
55′	Shaly measures, some sandstone.
35′	Sandstone, hard, massive, conglomeratic, forming a bold bench.
65′	Not well exposed, but evidently contain much sandy shale and sandstone.
30′	Sandstone, massive, forms prominent bench.
45′	Soft measures not well exposed, (No. XI?)
12′	Foliated sandstone, sometimes massive and conglomeratic with *flat pebbles*. (*Sub-olean, Shenango SS.*)
18′	Shaly measures to railroad level.
10′	Concealed to well mouth.

Dickinson Well Record.

Sandstone,	138	to 138
Slate,	30	to 168
Fireclay,	2	to 170
Sandstone,	13	to 183
Slate,	42	to 225
Sandstone,	8	to 233
Soapstone,	27	to 260
Sandstone,	23	to 283
Dark slate,	14	to 297
Sandstone,	11	to 308
Slate,	30	to 338
Sandstone,	9	to 347
Slate,	11	to 358
Sandstone,	9	to 367
Red Sandstone,	10	to 377
Gray Sandstone,	9	to 386

Red Sandstone,	24	to 410
Flint,	½	to ——
Red Sandstone,	98½	to 509
Blue Sandstone,	6	to 515
Red Sandstone,	41	to 556
Blue Sandstone,	15	to 571
Red Sandstone,	22	to 593
Blue Sandstone,	5	to 598
Red Sandstone,	23	to 621
Blue Sandstone,	5	to 626
Red Sandstone,	6	to 632
Gray Sandstone,	43	to 675
Red Sandstone,	31	to 706
Gray Sandstone,	54	to 760
Light colored very hard—sometimes pebble bearing—sandstone,	10+	to 770

Total depth of well 772 feet.

Drilled at Ridgway about 1864-5. Authority, J. P. Lesley.

Wilcox Wells.

These three wells are situated on the West Branch of the Clarion river, 4½ miles north from Wilcox. The records exhibit the same features which by generalization may be expressed thus:

Gray Pocono:—Shale and gray sand, (including drive pipe)	100′
Red Pocono:—Red shale and red sandstone alternating with gray,	275′
Chemung:—Gray and brown shales, slates, and sandstones,	1500′+

Mr. Ashburner places the base of the Conglomerate (Olean) about 250 feet* above the well mouths. I am inclined to place it somewhat lower, but as there are no exposures near the wells, its horizon cannot be accurately determined. A coal bed has been discovered 370′ above the wells.

Wilcox Well, No. 3.

Loam and sand,	5 to	5
Loam and gravel,	5 to	10
Gravel and pebble,	10 to	20
Gravel and sand,	5 to	25

*In Mr. Ashburner's paper on "Oil Well Records," published since the above was written, the base of the Olean is placed 125′ above No. 2, (about 100′ above No. 3.)

Gravel and pebble,	5 to 30
Gravel and sandrock,	5 to 35
Quicksand and coarse pebble,	5 to 40
Fine sand and gray slate, [Drive pipe 43′,]	5 to 45
Gray slate,	35 to 80
Gray sand,	37 to 117
Red slate or shale,	18 to 135
Red shale rock, hard,	10 to 145
Gray sandrock,	10 to 155
Red shale,	5 to 160
Red slate,	20 to 180
Gray slate,	25 to 205
Red slate,	105 to 310
Red shale,	15 to 325
Gray slate and sand,	15 to 340
Gray slate and shell,	15 to 355
Red slate,	25 to 380
Gray slate,	15 to 395
Gray slate and shell,	20 to 415
Gray sand,	15 to 430
Gray slate,	5 to 435
Gray sandrock,	7 to 442
Clover seed rock,	8 to 450
Gray shale,	15 to 465
Dark gray slate and shell,	75 to 540
Gray slate and shell,	7 to 547
Gray slate. Cased 547′,	43 to 590
Gray slate, hard. Gas vein at 593′,	75 to 665
Dark hard gray shale,	30 to 695
Gray slate and sand,	5 to 700
Hard gray sand,	15 to 715
Light sand with shale,	5 to 720
White and gray sand,	55 to 775
Hard and fine gray sand,	25 to 800
Fine dark gray sand,	5 to 805
Gray slate,	5 to 810
Gray slate and shale,	5 to 815
Fine gray sand,	23 to 838
Red slate,	7 to 845
Gray sand,	25 to 870
Red slate,	10 to 880
Gray slate,	35 to 915
Red slate,	5 to 920
Gray slate,	15 to 935
Soft gray sand,	5 to 940
Soft gray and white sand,	15 to 955
Dark gray sand,	5 to 960
Hard gray sand,	5 to 965
Gray sand and slate,	5 to 970
Fine hard dark gray sand,	5 to 975
Red slate,	5 to 980
Gray slate,	35 to 1015

Hard gray sand,	20 to 1035
Gray slate,	35 to 1070
Gray sand,	10 to 1080
Gray shale,	15 to 1095
Gray sand and very hard shells,	5 to 1100
Soft gray sand,	15 to 1115
Gray and white shell,	10 to 1125
Close soft white sand, [oil smell at 1132′,]	20 to 1145
Hard gray shells,	20 to 1165
Gray slate, [gas and oil smell at 1182′,]	15 to 1180
White and gray sand and pebbles,	10 to 1190
Close white sand,	5 to 1195
Gray sandstone and white pebbles,	20 to 1215
Coarse white sand,	5 to 1220
Silver gray sand,	10 to 1230
Fine white sand,	5 to 1235
Gray slate and shell,	75 to 1310
Gray sand,	20 to 1330
White sand,	10 to 1340
Slate,	5 to 1345
Coarse gray sand,	10 to 1355
Soft white sand, 5′ gray in middle,	15 to 1370
Slate and hard shell,	15 to 1385
Gray hard shells,	30 to 1415
Gray slate, shelly at bottom,	25 to 1440
Hard gray sandstone,	10 to 1450
White sand,	5 to 1455
Gray slate,	35 to 1490
Hard gray shale,	5 to 1495
Gray sand,	5 to 1500
Close white sand,	10 to 1510
Gray slate, shelly at bottom,	25 to 1535
Hard white sand,	10 to 1545
Gray shell,	5 to 1550
Gray slate,	25 to 1575
Gray sand and shell,	15 to 1590
Gray slate,	15 to 1605
Gray sand,	20 to 1625
Gray slate,	10 to 1635
Gray slate, and shell, [gray shale—oil—at 1685.]	50 to 1685
Crevice, filled with quicksand,	2 to 1687
Dark sand, [oil at 1690′,]	3 to 1690
Crevice, with loose stones, containing oil,	5 to 1695
Dark sand, oil,	5 to 1700
Coarse sand, oil, to 1707,	5 to 1705
Loose slate,	10 to 1715
Light colored slate, [sandpumped oil at 1720?]	65 to 1780
Crevice, full of stones and sand—gas,	4 to 1784
Dark sand,	8 to 1792
Light colored slate,	16 to 1808
Hard fine sand,	15 to 1823
White and red sand mixed,	9 to 1832

Fine red and white sand,	11 to 1843
? to bottom of well,	7 to 1850

Cased $5\frac{5}{8}$″ casing at 547′ Production doubtful. Pumped since January 1st, 1878, and up to June 13th had not averaged one barrel per day of merchantable oil.

Marienville.

The Hunt and Towler well record given below furnishes an excellent connection between the Ridgway and Wilcox red bands and the red rocks of the Clarion oil belt. This well is situated near Marienville in Forest county.

Above the well the following succession is rather poorly exposed:

Sandstone in summit, very massive, resembling the Homewood sandstone,	50′+
Soft shales with thin coal seam and ore bed; a few sandy layers,	40′±
Concealed to well mouth, interval rather uncertain, but with no connection for dip,	=50′

Hunt and Towler Well No. 3.

Conductor,	8 to	8
Sandstone; yellow,	30 to	38
Slate; blue,	24 to	62
Coal,		—
Sandstone, pebbly,	98 to	160
Slate; blue,	25 to	185
Sandstone. Base of No. XII,	70 to	255
Slate, with red bands. No. XI,	70 to	325
Sandstone, white,	45 to	370
Slate, black,	85 to	455
Sandstone,	100 to	555
Slate, bluish-gray,	20 to	575
Sandstone, close, pebbly,	13 to	588
Slate,	204 to	792
Red slate,	25 to	817
Black slate and shells,	18 to	835
Red Slate, gas,	76 to	911
Black slate,	12 to	923
Slate and shells,	30 to	953
Gray sand,	15 to	968
Red rock,	10 to	978
Black slate,	25 to	1003
Gray sand,	20 to	1023
Black slate,	25 to	1048
Gray slate,	15 to	1063

Red slate,	15 to 1078
Black slate,	114 to 1192
Sand shells,	15 to 1207
Chocolate slate,	20 to 1227
Slate, sand shells, blue mud,	83 to 1310
Measured depth of well,	— to 1305

This record combined with the surface section shows a great development of the Conglomerate measures. A similar expansion of this series (No. XII) is seen on the Allegheny river at Great Bend in Warren county.

This Great Bend section is here introduced to show the character of No. XII, and the (almost?) total disappearance of the Red Pocono against a Chemung floor.

Kinzua, or Great Bend Section.

Summit Coal Hill Knob, above ocean,		2154
Concealed; soft measures,		8′
S. S. hard, massive, coarse, loose-grained, (about,)		20′
Concealed; soft measures,		25′
Coal; (reported,)		2′
Concealed; soft measures,		25′
Coal; (cannel,) overlaid by slates,	3′ 4″	
Fire-clay, (?)	7′ 0″	14′
Coal, (bituminous,)	4′ 0″	
Fire-clay, about		2′
Concealed, S. S., (reported,) containing soft measures,		61′
S. S. coarse and massive,		20′
Concealed soft measures with Quaker Hill Coal,		62′
Conglomerate, pea to hazelnut,	10′	
Conglomeritic, coarse S.S. with some conglomerate,	15′	
Conglomerate, pea to hazelnut,	15′	77′
Conglomerate and conglomeritic S.S. in thin layers,	33′	
Conglomerate; hazelnut to egg,	4′	
Total Conglomerate Measures,		316′

Upper Pocono, and Chemung.

Concealed, soft measures,	24′
S. S. massive, coarse grained,	32′
Shale; soft olive, with sandy layers 1″ to 6″ thick,	51′
S. S. dark, slaty, thin bedded, fine grained,	5′
Shale, sandy, underlaid by sandy slate, some thin sand beds,	39′
S. S. slaty thin bedded fine grained, some shale.	6′
Shale; with a few beds of slaty S. S. 6″ to 1′ thick,	41′
S. S. slaty fine grained,	3′

Shale; bluish, sandy and slaty,		17′
S. S. hard, thin bedded, slaty, bluish gray,		5′
Slates, sandy beds $\frac{1}{16}$ to $\frac{1}{2}$ inch thick; dark gray,		21′
S. S. grayish, slaty, false bedded and fine grained,		13′
Slate and shale,		4′
S. S. slaty thin bedded,		5′
Slate; sandy, with slaty shale, dark, beds 3″ to 18″ thick,		12′
Red and greenish sandy shale,		3′
S. S. massive, fine grained, hard, grayish,	4′	
flaggy, fine grained, grayish,	4′	17′
massive loose grained, fine,	9′	
Shales, soft olive, clayey near bottom,		43′
Red sandy shale,		2′
Shale; olive and blue, sandy,		9′
S. S. hard, massive, grayish iron stained,	10′	
hard, flaggy false-bedded,	2′	14′
hard, massive,	2′	
Shale; bluish olive,		3′
Concealed, (soft)		62′
Shale; soft bluish, a few hard bands,		15′
S. S. flaggy, blue,	1′	
—— Shale, blue sandy,	1′ to 1′ 6″	3′
S. S. hard, blue,	1′	
Shale; blue iron stained,		9′
S. S. massive fine grained, hard, oxide of manganese spots,	3′	
false bedded, yellowish gray,	7	
massive hard, yellowish gray,	2′	18′
coarse grained iron stained, (sanguinolites,)	3′	
pebbly—pebbles size of wheat,	2′	
thin bedded fine grained,	1′	
Shale; olive to chocolate, concretionary,		27′
Concealed from 26′ to 45′,		26′+
S. S. shaly, greenish gray, mixed with red,		18′
Concealed, softer measures,		11′
S. S. or sandy shale, greenish gray and red,		10′
Shale; olive and brownish,		34′
S. S. thin bedded, flaggy, 6′ to 8′,		8′
Shale; dark,		15′
Spirifer band,		1′
Shale; soft, olive and chocolate color,		8′
Shale; dark and slaty, breaking into aciculous fragments,		6′
Concealed to level of Kinzua creek,		6′
Total Upper Pocono and Chemung,		646′+

The Lower or Red Pocono is apparently absent in this section and the Chemung lies high up near the Conglomerate. It is not possible to place with any accuracy the dividing line between the Upper Pocono and the Chemung. The total thickness of rocks described in section is 926′+.

The exposures from which this section was made, are the best that have been found in Warren county.

Snydersburg Well.

This well is situated at Snydersburg in Clarion county, at the eastern extremity of the Clarion Oil-belt, eight miles northeast from Shippenville.

The well mouth is ninety feet more or less below the Ferriferous Limestone. It shows the horizon of No. XI by a red band at a depth of 300 feet, and the place of the Oil sand group is marked by two heavy red bands.

Well mouth, above ocean, (bar.,)		1470±
Conductor,	14 to	14
Bluff sand,	156 to	170
Mountain sand,	70 to	249
Slate and shells,	60 to	300
Red Rock,	7 to	307
Slate and shells,	282 to	589
Soft slate,	2 to	591
Pebble sand,	5 to	596
Shells, slate and sand,	138 to	734
First sand,	30 to	764
Slate,	110 to	874
"Little" Red Rock,	27 to	901
Second sand,	20 to	921
White sand,	5 to	926
"Big" Red Rock,	40 to	966
Black slate,	50 to	1016
Stray sand,	17 to	1033
Third sand,	12 to	1045
Slate,	9 to	1054
Third sand,	11 to	1065
Slate,	35 to	1100
Fourth sand,	11 to	1111
Slate,	96 to	1207

Sligo Well.

This also shows the red bands of No. XI at a depth of 270 feet in the well.

The well is situated at Sligo in Piney twp. Clarion county, six miles southeast of the oil belt. The horizon of the oil sand group is marked by a series of red bands.

It was drilled in August, 1865 and was therefore a "wet-hole."

The Ferriferous Limestone is probably about 140 feet above the well mouth.

Conductor,	15 to	15
Slate; (soft and light, 22′, black 5′,)	27 to	42
Sandstone; hard,	7 to	49
Slate; soft and black,	6 to	55
Sandstone; hard,	7 to	62
Slate; shelly,	3 to	65
Coal,	2 to	67
Sandstone; (water at 128′,)	116 to	183
Slate; top hard, bottom soft,	85 to	268
RED ROCK; soft slate,	2 to	270
Sandstone; soft,	10 to	280
Slate,	90 to	370
Sandstone; close grained and blue,	20 to	390
Slate,	49 to	439
Sandstone; hard and blue,	27 to	466
Slate; soft "resembling fire-clay,"	284 to	750
RED ROCK; soft slate,	5 to	755
Sandstone; hard,	10 to	765
Slate; blue,	21 to	786
RED ROCK; (slate,)	29 to	815
Slate; blue,	77 to	892
RED ROCK; slate,	3 to	895
Slate; brown,	30 to	925
Slate; hard and soft alternating, (oil,)	112 to	1037
Slate; blue and shelly,	14 to	1051
Sandstone; blue,	30 to	1081
Sandstone; blue and RED,	36 to	1117
Sandstone; white and hard,	11 to	1128
Sandstone; RED and white,	13 to	1141
Sandstone; blue and RED,	10 to	1151

Salt water at 128′, 380′, 450′. No paying production of oil.

This and the preceding record are reprinted from report V.V. on Clarion county.

John Smith Well.

This is situated in Brady twp. Butler county in prolongation of a 22° line S. W. from the Venango oil belt at Bullion Run. The record below is reprinted from report V. to show the connection between the Beaver River and Clarion county sections:

Slate and fire-clay,				230 to	230
Limestone; FERRIFEROUS,				15 to	345
Slate and clay,				27 to	272
Sand-rock,				18 to	290
Black slate,				110 to	400
Sand-rock,				65 to	465
Slate,				3 to	468
Mountain sand,				100 to	568
Slate and shells, (No. XI?)				72 to	640
Gray sand,				50 to	690
Slate and shells,				10 to	700
Sand-rock,				30 to	730
Slate,				180 to	910
Sand-rock,				26 to	936
Slate and shells,				119 to	1055
RED ROCK,				60 to	1115
Slate and shells,				15 to	1130
First sand,				60 to	1190
Slate,				85 to	1275
Second sand,		Second sand,		20 to	1295
Slate,				20 to	1315
Sand-rock,				25 to	1340
Slate, (Note 1,)				55 to	1395
Granite, (Note 2,)				5 to	1400
Slate,				31 to	1431
Third sand, (off color,)				19 to	1450
Black slate, (pocket,)				8½ to	1458½

"Note 1. 55′. This should be the "Granite," which is a dark, sandy slate.
Note 2. 5′. This should be the "Stray" sand—it *underlies* the granite,"
The Third sand was poor and quite shelly, and yielded no oil.
N. B. The above record is given as received in the driller's nomenclature. A shell is any hard stratum, usually sandy, but generally quite fine grained.

New Castle Well.

This is situated at New Castle in Lawrence. The surface section showing the Conglomerate measures is supplied from a series of exposures in the immediate vicinity of the well.

Well mouth above ocean in feet, approximately,				+ 800
Gravel,	Drift,		15 to	15 =
Blue mud and quicksand,			125 to	140 =
Slate, rock,			3 to	143 =
Slate,	Cuyahoga shale,		61 to	204 =
Sand shale,			54 to	258 =
Slate rock,			54 to	312 =
S. S., gray,			44 to	356 =
Slate,			26 to	382 =
S. S., white, salt water and oil,	Bera Grit,		78 to	460 =
Slate,			35 to	495 =

Red Rock,	Bedford shale,	70 to 565	=
Slate,		151 to 716	=
S. S.,		43 to 759	=
Slate,		70 to 829	=
Sand shales,		30 to 859	=
Slate,		75 to 934	=
S. S., gray,		31 to 965	=
Red rock,		3 to 968	=
Slate,		19 to 987	=
Slate,		207 to 1194	=
Shales, hard,		21 to 1215	=
Slate, hard,		155 to 1370	=
Sand shales,		47 to 1417	=
Slate, hard,		68 to 1485	=
S. S., gray,		50 to 1535	=
Slate,		154 to 1689	=
S. S., gray,		8 to 1697	=
Slate,		64 to 1761	=
S. S., gray,		15 to 1776	=
Slate,		69 to 1845	=
S. S., gray,		17 to 1862	=
Slate,		103 to 1965	=
S. S., gray,		80 to 2045	=
? about,		655 to 2700	=

Drive pipe, 143—7.12′. Cased with $5\frac{5}{8}$″ casing at 468′.

Gas at 313′, 657′, and 717′. Salt water and oil show at 395′.

Chapter XI.

The Queen's Run Coal Basin in Clinton County, North of the Susquehanna River. By Franklin Platt.*

The Allegheny mountain is cut through by the Susquehanna river 3 miles above Lock Haven; and the river having thus entered the First sub-basin winds rather sinuously through and across it and cuts the first anticlinal sub-axis at a point about 5 miles beyond. While the river is in this first sub-basin the Tangascootac creek enters it from the South and Lick run and Queen's run from the North. Coal and fireclay have been extensively opened and worked on these latter runs.

The region was examined by the First Survey of Pennsylvania and the facts were thus stated in the Final Report.†

"The rocks along the Susquehanna river are the argillaceous sandstones forming the thick bands at the alteration of the [Catskill and Pocono] series, dipping at a considerable angle to the northwest. At the mouth of Lick run these give place to [Pocono] rocks, having their usual character of a brown slaty sandstone, but containing a few bands of a siliceous conglomerate, somewhat like the [Pottsville] Conglomerate, though darker. Above the Sandstone lie the Umbral red shales in two separate strata, alternating with a gray sandstone, referable either to the [Pocono or Pottsville] Series. The lowest of these red shales is a bed 65 feet in thickness, containing two seams of *iron ore;* one only about 6 inches thick; the other, 20 feet above it, being about 10 inches. The ore is apparently good, but probably not sufficiently abundant to be valuable.

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* This report was written in 1876 from data obtained when selecting samples of fireclays and firebrick for the State tests made in Harrisburg. See Report MM, p. 270.

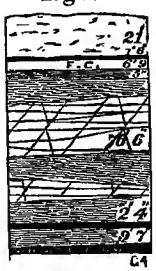
† Final Report. Rogers, vol. II, pp. 527, 528.

"A similar ore has been discovered on Queen's run, 1½ miles northeast of the Queen's Run Mines, where it promises a greater quantity. Between the two seams of ore occur buff colored and red shales. Overlying this red shale is a thick stratum of gray sandstone, analagous to the [Pocono] gray sandstone, about 250 feet thick. This supports another thinner bed of [M. Chunk] red shale. At the mouth of Queen's run the [Pocono] Sandstone contains a seam of fireclay 4 or 5 feet thick, which is a little too sandy, but may be worth working, if mixed with a more argillaceous variety. At the mines on Lick run the strata have been bored from the highest ground down to the upper bed of the red shale. At different points where this was done the strata do not precisely correspond. One of the most important of the beds, a seam of coal, is absent over a considerable extent, owing to a dislocation in the strata, or to other causes not yet ascertained.

"In one of the knobs where the position of the coal appears to be represented by slate and sandstone, we have the following section:

Soil,	—″
Coal, not under sufficient cover to be hard, (Here only 1′ 6″,)	5′ 6′ to 0″
Fireclay,	6′ 9″
Brown slate,	5′ 0″
(Coal should here occur 19 feet below the brown slate, 6 feet thick, and containing 16 inches of slate, but it is absent.)	
Dark slate and flaggy sandstones,	76′ 6″
Coal,	2′ 4″
Dark slate,	9′ 7″
Coal,	3′ 6″ to 5′ 0″

Fig. 19.



Lick Run, Farrandsville.

"This is the lowest coal-bed of the basin, as it was mined by the Farrandsville Company for the use of their furnace, where it underwent the coking process without the aid of ovens. It was then sent by an inclined plane and railroad to the furnace at the base of the mountain. The second coal seam in the ascending order was not worked, the coal being impure; but the third, where the ground is sufficiently

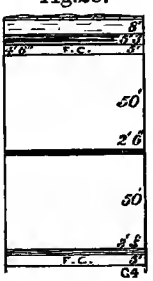
elevated to embrace it, has been wrought to some extent, yielding a better coal than either of the other two. It is now, however, nearly exhausted. This upper coal seam, lying usually near the surface of the highest ground, has generally an unsound roof, which unfits it to be mined. It measures commonly 6 feet in thickness. It is removed to expose the fireclay which lies immediately beneath it, found to be of a superior quality for the manufacture of firebrick. This fireclay, from 6 to 7 feet thick, is destitute of grit, and furnishes an admirable firebrick. Under it lies a bed of shale, containing a layer of *nodular iron ore* of no great purity or richness.

"Beneath the lowest bed of coal slaty sandstones and shales occupy a thickness of 46½ feet, succeeded by 25 feet of red shales, this by upwards of 200 feet of gray sandstone, and this again by the lower bed of red shale. It is very remarkable that we nowhere find the rocks occupying the position of the [Potts.] Conglomerate, possessing the conglomerate character, while in every other neighborhood in the same basin, as at the First fork of Pine creek and on the Tangascootac, this rock exists in its true type and features."

In examining the fireclay deposits on Lick run, above Farrandsville, in 1875, the following facts were noted. The lowest coal and underlying fireclay bed are opened 1 mile up Lick run. The section intervals as leveled by barometer showed:

Fig. 20.

Surface.	
Sandstone,	1′ 0″
Carbonated clay slate,	8′ 0″
Coal and partings,	5′ 3″
Fireclay,	4′ 6″ to 5′ 0″
Interval rocks,	50′ 0″
Coal, worthless,	2′ 6″
Interval rocks,	50′ 0″
Coal and Partings,	3′ 5″
Fireclay,	5′ 0″



Lick Run.

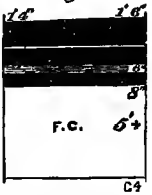
The lowest coal bed is opened 390 feet above the railroad level at Farrandsville and 425 feet above the level of the Susquehanna river at that point.

This bed was extensively wrought some 40 years ago to supply coal to make the coke used in the old Farrandsville Furnace. The furnace has been long out of blast and the coal bed is now only worked to supply the needed fuel for the Farrandsville Fire Brick Works.

The coal as measured in the mine showed:

Slate roof.	
Coal,	1′ 4″ to 1′ 6″
Slate,	0′ 1″
Coal,	8″ to 10″
Slate,	6″
Coal,	8′
Fireclay, hard,	5′ 0″+

Fig.21.



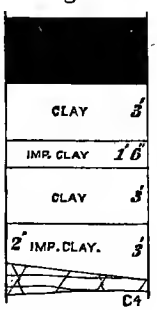
Lick Run, lower coal bed.

The coal appears to be somewhat sulphurous but answers well for the purpose for which it is now used, as it is a strong steam coal.

The fireclay underlying the coal bed is of unusual excellence. As measured in the mine where it is now worked, about one quarter of a mile south of the coal mine described above it measured:

Fig.22

Coal, lower bed, in all,	3′ 6″
Clay, hard,	3′ 0″
Parting, impure clay,	1′ 6″
Clay, hard,	3, 0″
Clay, impure, micaceous,	2′ to 3′ 0″
Sandstone floor.	



Lick Run, lower fireclay.

The two hard layers, 3 feet thick each, giving 6 feet thick of clay, in all, are extensively worked for the Farrandsville Fire Brick Works.

A specimen of the hard clay was forwarded to the State Survey Laboratory in Harrisburg and yielded on analysis: (D. McCreath.) See Report MM, p. 265, (106.)

Silica,	42.180
Alumina,	38.960
Protoxide of iron,	.760
Titanic acid,	3.360
Lime,	.510
Magnesia,	.180
Alkalies,	1.000
Sulphuric acid,	.010
Water,	13.790
	100.750

The analysis shows a very superior character of clay, noticeable for its low percentage of Iron, Lime and Magnesia, and for the high percentage of Titanic Acid.

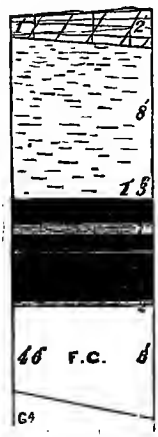
The middle coal bed, lying 50 feet above the lower coal bed, has been opened up, but is not worked. It proved to be small, irregular and poor in quality; and in this region on Lick run may be put down as utterly worthless for any practical purpose.

The upper coal bed, 50 feet above the Middle Coal, and 100 feet above the lower coal is only caught on the hill top and covers therefore a small area and under imperfect cover.

As measured in the open cut on the hill top the coal shows:

Surface.	
Sandstone,	1′ to 2′ 0″
Carbonated clay slates,	8′ 0″
Coal,	1′ 3″
Slate,	7″
Coal,	9″
Slate,	0′ ½″ to 0′ 1″
Coal,	2′ 6″
Slate,	2″
Fireclay, soft,	4′ 6″ to 6′ 0′

Fig. 23.



Lick Run Upper coal and fireclay.

The coal was weathered from imperfect cover, where examined; but is apparently of excellent quality when in order.

The fireclay is soft, and lies all in one bench without partings.

A specimen of the clay analysed at the State Laboratory showed: (D. McCreath.) See Report MM, p. 265, (105.)

Silica,	63.880
Alumina,	24.140
Protoxide of iron,	1.600
Titanic acid,	not determined.
Lime,	.200
Magnesia,	.684
Alkalies,	2.952
Sulphuric acid,	.158
Water,	6.770
	100.384

The clay is shipped 1½ miles to the Fire brick works of Messrs. Frederick, Monroe & Co. at Farrandsville. They have large works, having a capacity of 9000 bricks *per diem.*

They also ship raw clay to the Harrisburg Firebrick Works to mix therewith the Blue Ball (Clearfield county) Fireclay.

The shipments from Farrandsville are largely to iron works, about one half being large bricks for boshing and lining.

In view of the difference in the analyses of these clay, the hard clay being rich in titanic acid and the soft clay carrying none of it, the uses of the different clays and their mixings are instructive.

For firebrick, hard clay alone is used.

For boshing and lining, one half hard clay (lower bed) and one half soft clay (upper bed.)

For tiles, soft clay alone is used.

The mill uses water power and has very complete machinery for thorough grinding and mixing of the clays.

*"At Queen's run, the same beds of coal and fireclay occur which we see at Farrandsville, with this difference, that the uppermost coal seam is there under an ample covering, and ranges over a tolerably extensive surface, being the only bed mined. Its thickness varies from 5 feet to 3 feet 9 inches. The coal is superior and finds a ready market along the Susquehanna.

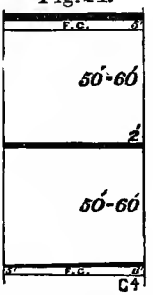
*Final Report, Rogers. Vol. II, p. 528.

"The fireclay at this place is occasionly 8 feet thick. A bed of coal about 4½ feet thick occurs not far beneath it. This does not appear in the coal measures above Farrandsville. The other beds in the series are supposed to occur here though their existence has not been positively ascertained. At the mouth of Queen's run firebricks have been made to a moderate extent, and at Farrandsville on a more extensive scale. . . . The extreme horizontality of the rocks observable in ascending the Susquehanna from Queen's run is undoubtedly due to the dying down of one of the broad axes of Tomb's Run Valley, which crosses Pine creek about 7 miles above its mouth, and passes under the turnpike west."

In examining the fireclay bed on Queen's run some additional facts were gathered. The lower fireclay and coal were opened about 2 miles up the run, and 652 feet by barometer above the level of the Susquehanna river at the mouth of Queen's run. The vertical section of the measures corresponds closely with that already given upon Lick run. It shows:

Fig. 24.

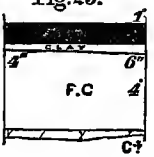
Upper coal,	4′ 0″
Fireclay (*upper*),	5′ 0″
Interval rocks,	50′ 0″ to 60′ 0″
Coal, worthless,	2′ 0″
Interval,	50′ 0″ to 60′ 0″
Coal,	1′ 6″ to 2′ 0″
Fireclay (*lower*),	5′ 0″ to 6′ 0″



The *lower coal and fireclay* where opened at mine No. 1, show:

Fig. 25.

Roof, imperfect, weathered.	
Coal, weathered,	1′ 0″
Dark colored clay,	4″ to 0′ 6″
Fireclay (*lower*), hard,	4′ 0″
Sandstone floor reported.	



The clay is all taken out, dark colored and hard, and used in the Firebrick Works at the mouth of the run. The mine runs in northwest and is on a level.

A specimen of this hard *lower* fireclay was forwarded to Harrisburg and yielded on analysis at the State Laboratory: (D. McCreath.)

Silica,	42.440
Alumina,	36.685
Protoxide of iron,	2.128
Titanic acid,	4.000
Lime,	.200
Magnesia,	.276
Alkalies,	.718
Sulphuric acid,	.820
Water,	13.370
	100.637

At another opening on this lower fireclay bed, only a few hundred yards away, the measures showed:

Coal, rotten,	1′ 6″
Fireclay (*lower*), soft,	7 0″

So different was the appearance of the fireclay that it would not have been recognized as identical with the hard clay just described. Moreover it works differently in use. A specimen of this soft clay yielded on analysis: (D. McCreath.)

Silica,	63.180
Alumina,	23.700
Protoxide of iron,	1.200
Titanic acid,	1.460
Lime,	.170
Magnesia,	·470
Alkalies,	2.520
Sulphuric acid,	.190
Water,	6.870
	99.700

The analyses show how totally the character of the fireclay deposit has changed within a few hundred yards.

The middle Coal Bed has been opened up on Queen's Run, but proved, as on Lick Run, small, uncertain and worthless.

The *upper* coal bed and its underlying *fireclay* were very extensively worked on Queen's Run many years ago. The mines are now all fallen shut. This is the upper bed of the Farrandsville Lick Run section; and the description and analyses of the *upper fireclay* given on page 8, will answer for this upper fireclay on Queen's Run.

The *upper coal on Queen's Run* covered a much larger area than on Lick Run, and has abundant cover over it. It was therefore in excellent order, and averaged 4 feet or more of coal.

This coal was shipped to Prof. W. R. Johnson, for his experiments in testing coal for the U. S. Navy Department. His report showed the coal to be of so high a grade as a steam coal, that a few of his figures are reproduced below. They are of interest, as showing what may be expected of the coal not yet worked out of this bed on the hill on Queen's Run.

"The exterior characters of this coal are, a *color* almost uniformly shining jet black, except, of course, the faces marking the planes of deposition, in which the usual reedy matter, in the state of mineralized charcoal, gives a dull deep black, with numerous well marked but small organic remains.

The main partings are well defined, and incline to the surfaces of deposition in angles of 85° and 95°. The cross partings are also, in many specimens, unusually well defined; smooth and brilliant plane surfaces, inclined to the main partings in angles of 88.5° and 91.5°, and to the surfaces of deposition in 70° and 110°. The coal thus separates into rhombic prisms.

Occasional specks of sulphuret of iron present themselves in the natural partings.

The specific gravity of one specimen of the coal was found to be 1.3225, that of another 1.3404; the mean of which gives the calculated weight of 1 cubic foot of solid coal equal to 83.22 pounds.

One specimen examined for sulphur gave 0.1019 per cent. of that ingredient.

The composition is as follows:

	Specimen a.	*Specimen b.*
Moisture,	0.559	0.679
Other volatile matter,	17.791	17.071
Earthy matter,	6.510	7.570
Fixed carbon,	75.140	74.680
	100.000	100.000
Volatile to fixed combustible,	1:4.223	1:4.375

Besides the preceding analyses, a comparative trial was made on forty specimens; from each of which a fragment was taken, and a portion of the powder of the whole subjected to the usual steps for determining the constituents. This gave:

Of moisture,	0.131
Other volatile matter,	18.676
Earthy matter,	7.750
Fixed carbon,	73.443
	100.000
Volatile to fixed combustible,	1:3.93

The ashes are almost perfectly white.

When tried in the chain shop, this coal was found eminently useful for that kind of work.

In the performance of ordinary smith work, to which it was applied in the anchor shop, the result was also highly satisfactory. It gave little cinder, a coke soft and yielding, and a form of fire abundantly hollow for all the purposes there required."

The above analyses and description sufficiently illustrate the unusual excellence of this upper coal bed where formerly worked on Queen's Run.

In view of the analyses of the *Queen's Run fireclay* given above, it is interesting to know their special uses and how they are mixed.

Tiles are made from the soft clay alone.

Bricks for lining and boshing are made from one half hard clay and one half soft clay.

The nine inch brick are made from the hard clay alone.

In the testing made of different fire bricks by the State Survey, at the Shaft testing furnace of the Harrisburg Firebrick Company, the report says:

"Two Queen's Run Bricks, one of them made of hard clay, the other of half hard and half soft, presented so bad an appearance in the furnace in 1 hour 35 minutes, that they were taken out. The result showed that the appearance of the bricks in the furnace was too deceitful to have any reliance placed upon it. The brick of hard clay had run on bottom and lower edges.

The brick containing one half soft clay lost one of its corners by cracking, and also showed cracks through its mass. The lower edges had given away badly."

In a second and more severe test, made of those bricks which stood up longest in the first trial, the report says:

"A Queen's Run and a Clearfield brick both had one end melted."

Speaking broadly, the tests showed great standing up power for the Queen's Run bricks.

The Firebrick Works, at the mouth of Queen's Run, were widely known in past years for the excellence of the material furnished by them.

They are not now working. It needs only improved machinery for crushing, grinding, and mixing the clays, to render the name of the Queen's Run brick as well known as in the past.

The Farrandsville bricks, which are well made, will serve as a sample of what the clay will do when properly and efficiently worked up.

There is an enormous outspread through this region (including the Lick Run region, of this fireclay deposit; a deposit so great that it may be worked upon for many years without appreciately affecting the geological estimate of quantity.

The question as to the geology of the region is not settled. The upper coal and upper fireclay are only found on Queen's Run between Jervy and Ram Runs; that is on the Eastern side of the basin, or rather Southern side, for the mountains here run more nearly East and West.

Now this dip is observed at the Old Mines, a general dip to the North 15° West, would bring this upper coal and clay into the hills to the North and Northeast. It cannot be found there by any researches made as yet. Either a subordinate anticlinal roll comes in to prevent the measure from crossing the ravine on the observed dip, or there is a fault. The former is much more likely. The question is a practical one involving considerable interests.

Near Whetham Station on the Philadelphia and Erie

Railroad, 5? miles above Farrandsville, the upper bed of the Lick Run and Queen's Run section has been caught on the mountain top, 1045 feet by barometer above the level of the Railroad Station.

The bed covers only a small area; the only mine is now fallen shut; and the general dip is to the North, putting the coal in a different basin from the Farrandsville and Queen's Run openings on the same coal. It has been reported as having shown a 6 foot coal bed.

There has been no effort to develop as yet at this point the fireclay deposit, which lies 100 feet below this upper coal on Lick Run and Queen's Run.

Chapter XII.

The Tangascootac Coal Basin in Centre and Clinton Counties, South of the Susquehanna. By Franklin Platt.

In the Report of Progress in the Clearfield and Jefferson District for 1874 (Volume H of Reports of the Second Geological Survey of Pennsylvania) while describing the Snow Shoe Coal Basin and its development (pp. 67–79) it was stated in the text and shown on the map (Plate VI) that the first sub-basin points off to the Northeast of Snow Shoe, the Lower Productive Coal Measures, with Coal Beds A, B, and over perhaps limited areas Bed D, occupying detached hill tops.

The first sub-basin is bounded on the East by the even and regular crests of the Allegheny Mountain, which is here capped by the massive Conglomerate of XII; but the rocks are lying so nearly horrizontal northwest of the crest, that the moderate falling off in height about compensates for the slight sinking of the measures to the northwest, and the lowest coal beds are not found in the hills until some miles west of the main crest of the Allegheny mountain. At Snow Shoe this distance is about 3 or 4 miles; and this distance is continued on to the northeastward.

The western boundary of the First Sub-basin is the anticlinal Sub-axis which divides this First Basin. This Sub-axis has already been described as it runs through Clearfield county and coming Northeastward passes between Snow Shoe and Karthaus, at or near Pine Glen. Northeastward of Pine Glen it seems to keep a straight line parallel with the line of the Allegheny Mountain. It is a high, broad backed anticlinal, carrying the Conglomerate of XII high up into the hill tops, making it the surface rock, and confining the Lower Productive Coal Measures to a narrow

and restricted area in the center of the synclinal basin included between it and the Allegheny Mountain. In this narrow line the coal basin runs on northeast from Snow Shoe across Beech creek, between the forks of the Tangascootac creek, and on Queen's Run and Lick Run on the north side of the Susquehanna river.

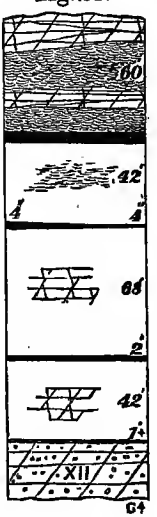
Between Snow Shoe and the Tangascootac mines the country is an absolute wilderness, far removed at present from any market, and of course entirely unopened to develop either coal or iron ore.

At the time of the examination for the First Geological Survey there was one opening made on a coal bed on Beech creek. The coal was four feet four inches thick, with a thin seam of slate; of good character and marking itself by a well defined bench or terrace near the summits of the hills. This bed was found 60 to 70 feet above the top of the siliceous Conglomerate.

Tangascootac Basin.

In the Tangascootac region however the coal beds were opened and mined for shipment many years ago, and the vertical section of the measures at that point as compared

Fig. 26.



Surface,	
Sandstone and shales,	60′
Coal (*upper*),	5′
Interval, (Shale?)	42′
Coal (*middle*),	4′ to 4″
Interval, (Sandstone?)	68′
Coal (*lower*),	2′
Interval, (Sandstone?)	42′
Iron ore, lean,	1′+
Conglomerate of XII.	

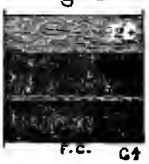
with the Snow Shoe vertical section (H p. 69) miles away shows so little variation in the measures and such regularity in the size of the coal as to give a fair idea of what may be expected in the region between these points whenever the hill tops take in the Lower Productive Coal Measures.

At the old openings on the north side of the South Fork of Tangascootac creek, at the Rock Cabin mines, the following vertical section shows (Fig. 26).

The *upper* bed of coal is the one which has been most extensively mined, and from it nearly all the Tangascootac coal which has reached market has been shipped. The coal showed (Fig. 27):

Fig. 27

Roof, black slate,	2′ or more.
Coal,	2 3″
Black slate parting,	4″
Coal,	2′ 3″
Fireclay floor.	



The coal contains much iron pyrites, both scattered through the mass of coal and as "sulphur balls" in the coal and parting slate. It was largely owing to the fact that the coal from this basin was shipped out without any care being exercised to remove these "sulphur balls," that the market for the coal fell off.

A specimen of coal from this upper bed, mined not less than 22 years ago, and exposed during all that time at the old dump, was forwarded to Mr. McCreath, at Harrisburg, and yielded on analysis:

Water at 225°,	.730
Volatile matter,	18.190
Fixed carbon,	57.719
Sulphur,	.981
Ash,	22.380
	100.000

It must be remembered that this specimen of coal had been exposed to the weather for 22 years. The analysis is not given to show the exact character of coal found on mining the bed, but as showing chiefly the effect of such weathering. The reduction in percentages of sulphur and volatile matters, raised the percentage of ash and fixed carbon.

It shows moreover that the effect of weathering is less than is usually attributed to it.

The same remarks apply to the analysis of a weathered specimen of the lower coal bed given below.

The *middle* coal bed was opened up at the Rock Cabin mines, and proved a total failure. This is the "rolling bed," so named from its frequent and sudden variations in size. The floor is very uneasy, and at the Rock Cabin opening the coal varied from 4 feet down to 4 inches in thickness.

The same coal has been opened and worked many years ago at the Irvin and Spering mines, about one and a half miles below the Rock Cabin mines, and on the south side of the Tangascootac creek. It yielded a good coal, but the floor was too irregular and the variations in size too great.

The area covered by it south of the South Fork was also quite limited.

It is stated that the fireclay floor of the bed at Spering's and Irvin's was of excellent quality. The mines are now fallen shut, and cannot be examined.

The *lower* coal was opened and worked for shipment at the Rock Cabin mines. It proved to be a small but regular bed, ranging from 24 to 30 inches in thickness. It coked successfully, but was abandoned as too small to work.

A specimen of this coal mined not less than eight years ago, and exposed during that time at the old dump, was forwarded to Mr. McCreath, at Harrisburg, and yielded on analysis:

Water at 225°,	.550
Volatile matter,	20.845
Fixed carbon,	67.801
Sulphur,	.659
Ash,	10.145
	100.000

These coal beds have been opened up in the past on trial pits or for mining on a small scale at several places to the west of rock cabin, but nearly all these test pits are now closed.

The *upper* bed was opened about ½ mile west of Rock Cabin, and showed 6 feet of coal, but carrying so much slate interleaved as to spoil the bed at that place. It had 4 feet of hard black slate overlying, and then sandstone over that: and a hard fireclay floor, with micaceous sandstone underneath.

The *lower* is opened and has been worked about 1 mile west of Rock Cabin, near Reaville's Settlement. It was about thirty inches in thickness. This opening is on the south side of the South Fork, and the area covered there is small.

On the north side of the South Fork, about 1 mile west of Rock Cabin, the "Peacock Mine" shows an average of 3 feet of coal.

The iron ore lying below the *lower* coal bed has been opened up in a test pit but never mined for shipment. The thickness of the bed cannot now be measured: the ore as showing in specimens lying around the trial opening appears to be too lean to work.

A small furnace at Reaville's settlement was in blast for short time and made perhaps in all 1000 tons of iron.

The same iron ore shows its outcrop south of Reaville's settlement, but is not opened up.

The Tangascootac railroad ran from Reaville's and the Rock Cabin mines to the Susquehanna river, delivering the coal there on to the Philadelphia and Erie railroad or on to the canal. The rails are now taken up from part of the railroad, and the whole operation has been abandoned since about 1866.

These facts, scanty in number and usually partially imperfect in character, represent what can now be observed in this abandoned Tangascootac basin. At the time of the First Geological Survey of Pennsylvania some of the mines were in operation. The brief description of it by Assistant Geologist James T. Hodge, substantially given in the First Report is reproduced below.*

"Passing to the west side of the Susquehanna, the Coal

* Final Report, Rogers, Vol. II, page 529.

Measures next appear on the Alleghany mountain, on the south side of the Tangascootac creek. This stream runs nearly centrally along the basin for five miles, with a margin of comparatively broad and regular bottom lands on each side. Owing to the greater amount of denudation in the lower part of the valley, the Coal Measures do not there occur; but higher up they expand over a considerable extent of country and acquire a thickness of several hundred feet. The forest growth near the South Fork is open, consisting of fine hard wood and scattering white pines, and the surface changes from the steep mountain acclivities seen nearer the river to gently rolling hills and extensive plains. The rocks along the valley of the Susquehanna for about six miles belong exclusively to the [Pocono] Series. At the mouth of the creek this formation rises nearly to the top of the Allegheny mountain, and caps the hill on the north side of the stream. The first appearance of conglomerate is where it covers the east extremity of the Allegheny mountain. Tracing it west it gradually comes in at a greater distance below the summit, until, three miles from the river, the Coal Measures occupy the mountain top, and the white pebbly sandstone of the [Pottsville] Conglomerate lies under the summit and crops out high on the south side.

The hills on the north side of the Tangastootac do not reach the elevation of the Allegheny Mountain until we advance north several miles, when a change of the dip to the south brings up the lower rocks, but with an extremely gentle dip. Along the north side of the creek the knobs are capped by the Conglomerate as far up the valley as the forks. A little below this the Coal Measures first appear on the north side of the stream, and finally, farther towards the west, they occupy all the high ground between the heads of the two forks, but no coal occurs to the north of the North Fork, the hills there being capped by the Conglomerate.

The most eastern coal beds opened are south of the First Fork, at an elevation of about 530 feet above the stream, which, in the course of two and a half miles to the mouth,

descends 30 feet. The upper bed lies beneath a thick stratum of brown sandstone. It appears to be 4 feet thick, but at some distance in from the outcrop a fault causes it locally to be only 2 feet. The quality of this coal is excellent; it it is underlaid by a bed of good fireclay. There occur about 35 feet of other strata covering this bed over an area of perhaps 50 acres.

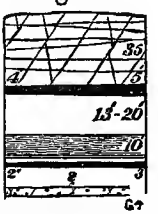
Another coal seam, somewhat slaty, 3 feet in thickness, lies about 30 feet lower down, at no great distance under which is the Conglomerate, forming a stratum nearly 100 feet in depth. This rock is here a fine sandstone, containing fine pebbles, and disintegrates into a fine sand, well adapted for making glass.

The next openings are on the south side of the creek, two miles above the forks. The upper bed occurs near the top of the hill; it is 4 feet thick, including some small seams of slate and fireclay. The coal is good; it breaks into rectangular pieces, and contains much mineral charcoal, occasionally in seams nearly half an inch in thickness, showing the fibrous structure of the coal vegetation. It is beautifully marked by thin alternating lamina of dull splint and splendent glance coal. A bed, supposed to be the same, has been opened at a lower level in a northwest direction, that being the course of the dip. At this latter place its total thickness is 4 or 5 feet, including one foot of dividing fireclay.

Section on Tangascootac Creek (*J. T. Hodge*).

Fig. 28.

Surface.	
Brown sandstone,	35′
Coal,	4′ 0″ to 5′ 6″
Unseen,	13′ 0″ to 20′ 0″
Blue slate,	10′ 0″
Bluer slate,	1′ 0″
Fireclay,	2′ 0″
Coal,	2′ 0″ to 3′ 0″



Between 20 and 30 feet under this occurs another coal seam, not well exposed, but apparently two feet thick; upon it rests two feet of fireclay, and over that 1 foot of black slate, surmounted by more than 10 feet of blue slate.

The rocks underneath the coal are entirely concealed, but the Conglomerate cannot be far below.

On the south side of the Allegheny Mountain there are two small benches near the summit, at some height above the steep slope, caused by the Conglomerate. The lower of these contains the "brown rock," while the upper one probably embraces a bed of coal.

The hills north of the North Fork constitute the north margin of this coal basin. They are higher than the hills around, being capped by the Conglomerate. Between the North and South forks coal measures extend through the hills for some distance. Indications of *iron ore* present themselves in the [M. Chunk] Red Shales, in a ravine 2 miles above the forks. Between 5 and 6 miles from the mouth, the Coal Measures are within 75 feet of the beds of the streams, the hills rising about 250 feet higher. Further west the surface becomes smoother and the extent of country embracing the Coal Measures much greater. The distance across the basin, from the Allegheny Mountain to the hills north of the North Fork, is apparently about 5 miles, but the actual area of the coal is more circumscribed, owing to the numerous valleys of denudation. In the district described, the indications of iron ore among the Coal Measures are unpromising."

From the facts as stated above the general features of the basin may be briefly stated.

The Tangascootac Coal Basin lies principally between the forks of the Tangascootac creek, extending from there westward to the valley of Beech creek.

The upper bed occupies only a small part of this area. It shoots out to daylight only a short distance east of the Rock Cabin mines; but is found in the hill top between the North and South branches of the creek for perhaps 1 mile west of the Rock Cabin Mines. It was shipped formerly both for gas and steam coal purposes.

The middle bed covers a much larger area. It is found at Irvin's and Spering's mines on the south side of Tangascootac creek; but the area covered there is small. It occupies however the region between the forks of Tangascootac

creek from a point about ½ mile east of Rock Cabin mines where it finally shoots out to day on the east, to a point about 1½ miles or more west of Rock Cabin mines.

The lower bed covers an area much larger than this. It is found on the south side of the South Fork of Tangascootac creek and covers an area which though more extensive than the middle bed, is however comparatively small. It has been worked on the Southeast at Reaville's settlement.

It occupies the region between the forks of the Tangascootac creek, (about two miles above its mouth,) westward to the waters of Beech creek, a distance of 5 miles.

It is obvious that the coal beds contained slate partings and much sulphur in the shape of "sulphur balls," but these impurities could be removed, in considerable part, by careful mining, and a reasonably clean coal furnished to market. The coal itself, when free free from the slate and pyrites of the binders, is clearly a good strong steam coal. But it must be noted that in these lower coals of the Lower Productive Coal Series the character of the coal yielded by any coal bed will change very greatly and very quickly; not more quickly or greatly than the manner in which the size of bed will vary, but very much the same. So that both the size of the bed, running in one bed here in this Tangascootac basin from 4 feet down to 4 inches in thickness, but also the character of the coal must be closely watched. As a general rule coal bed A of the series carries, in nearly all parts of the bituminous coal basin, more sulphur than the beds above it, this sulphur usually as iron pyrites in the binders, being so regularly present in large percentages as to make a marked and recognizable feature of the coal bed.

In the basin lying just north of the Susquehanna River in this First Bituminous Coal Basin, these same coals which were opened up and once worked at the Tangascootac mines were opened and worked on Queen's Run and Lick Run; the same coals in the same sub-basin, and only a few miles away to the northeast. Yet the Queen's Run coal was singularly free from impurities of all kinds.

It is a singular fact that while the fireclays of Queen's

Run and Lick Run, only 5 miles northeast of these Tangascootac mines, have been extensively opened and worked and enjoy a wide reputation for excellence of character, the same fireclay beds, underlying the same beds of coal, have never been worked on the Tangascootac. Their existence is known, but they have never been developed. Of the fireclay on the Tangascootac, therefore, nothing definite can be affirmed.

INDEX TO G⁴.

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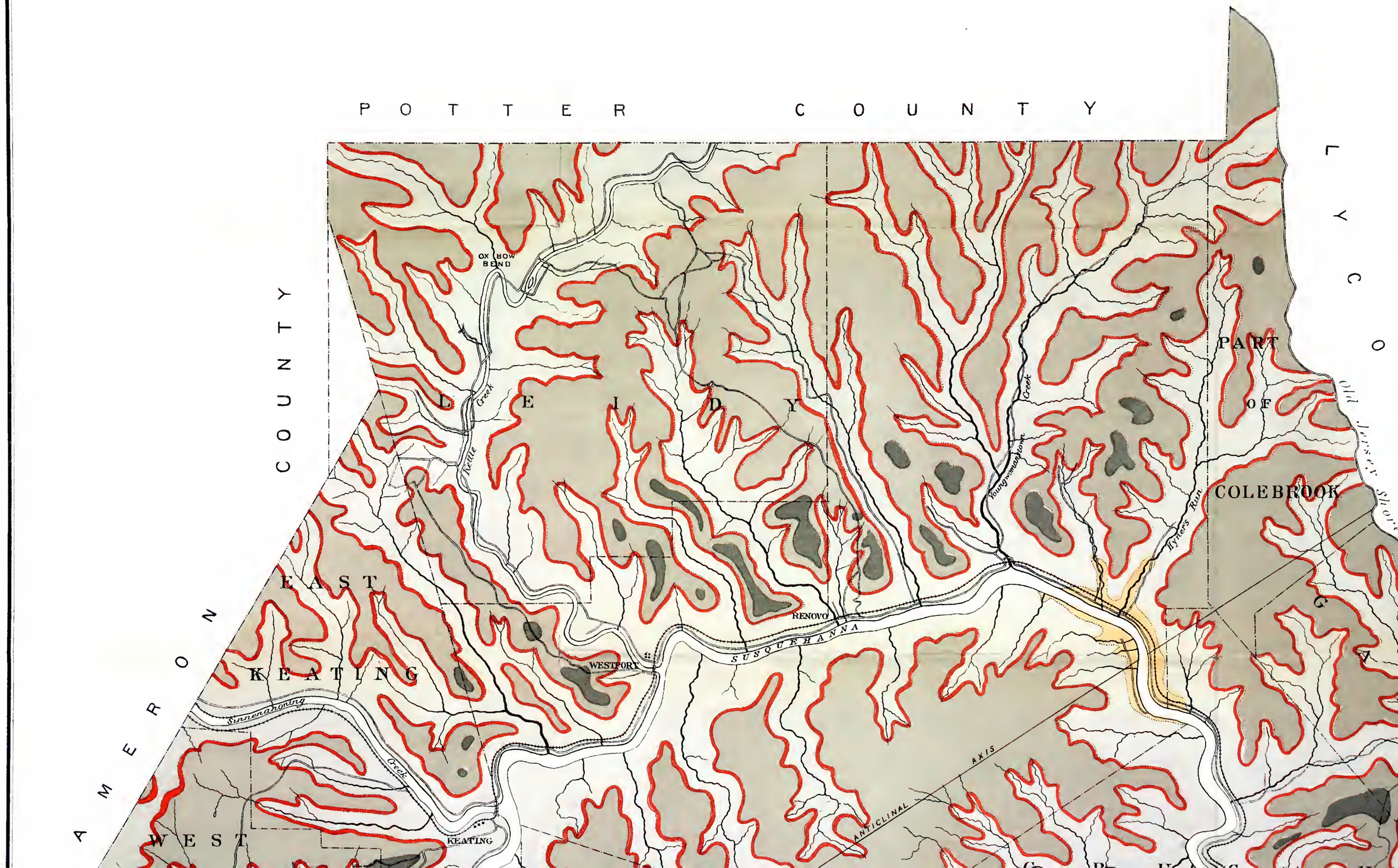
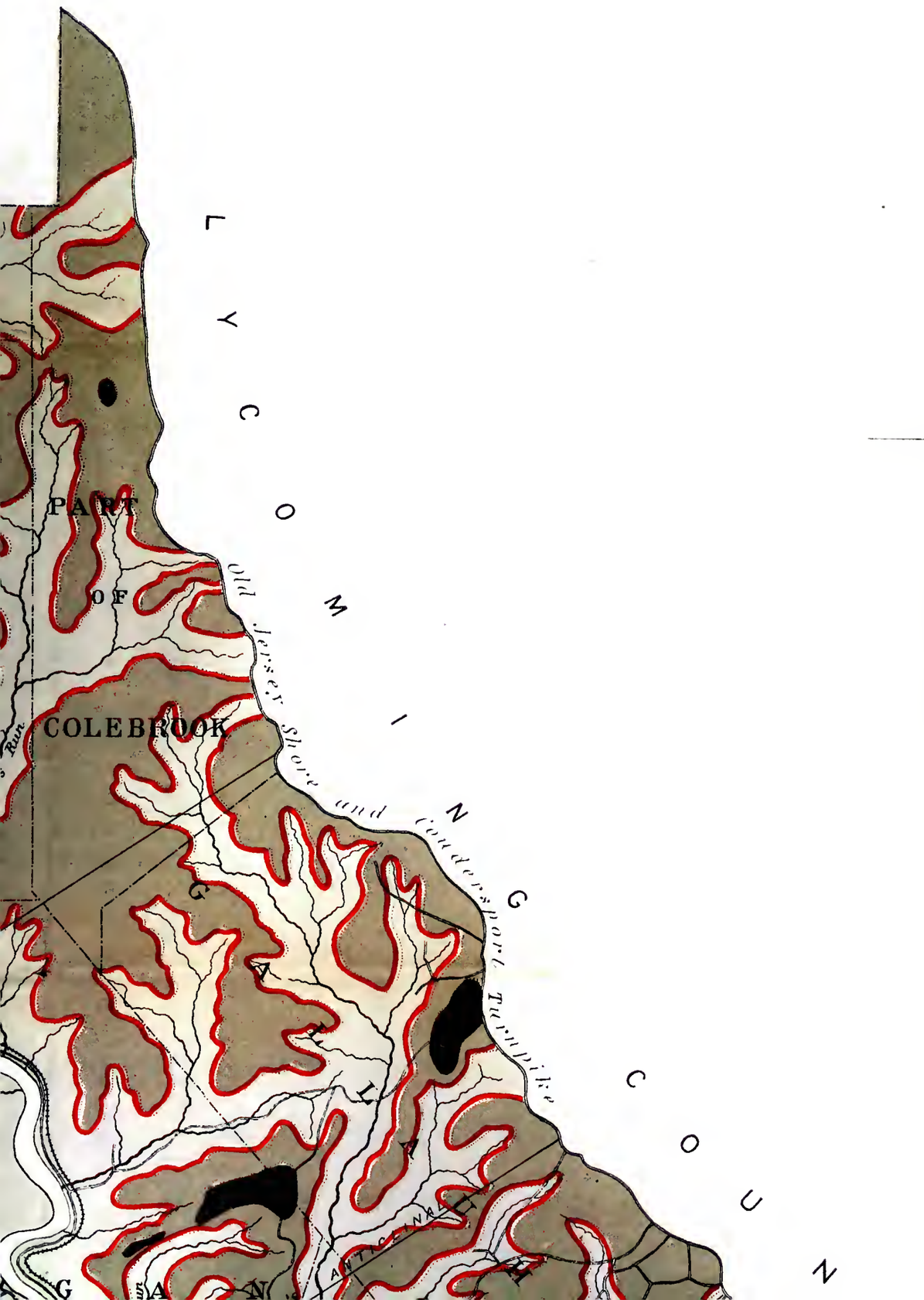

POTTER COUNTY
CAMERON COUNTY
CLINTON COUNTY
OX BOW BEND
LEIDY
PART OF COLEBROOK
EAST KEATING
WEST KEATING
RENOVO
WESTPORT
SUSQUEHANNA
Kettle Creek
Youngwomanstown Creek
Tyrers Run
Old Jersey Shore Line
Sinnemahoning Creek
ANTICLINAL AXIS



N

Magnetic Meridian of the Old Tract Surveys

Generalized Section at Queens Run

XIII.	Coal Measures		250'
XII.	Conglomerate Measures		250'+.
XI.	Red Shale		100'
X.	Pocono Sandstone		1175'
IX.	Red Catskill		2106
VIII 5764'	Chemung		3314'
	Portage		560'
	Genesee		1131'
	Hamilton		759'
	Marcellus		
VII.	Oriskany Sandstone		
VI.	Lower Helderbergs		825'

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

J. P. LESLEY, STATE GEOLOGIST.

GEOLOGICAL MAP

OF

CLINTON COUNTY

by

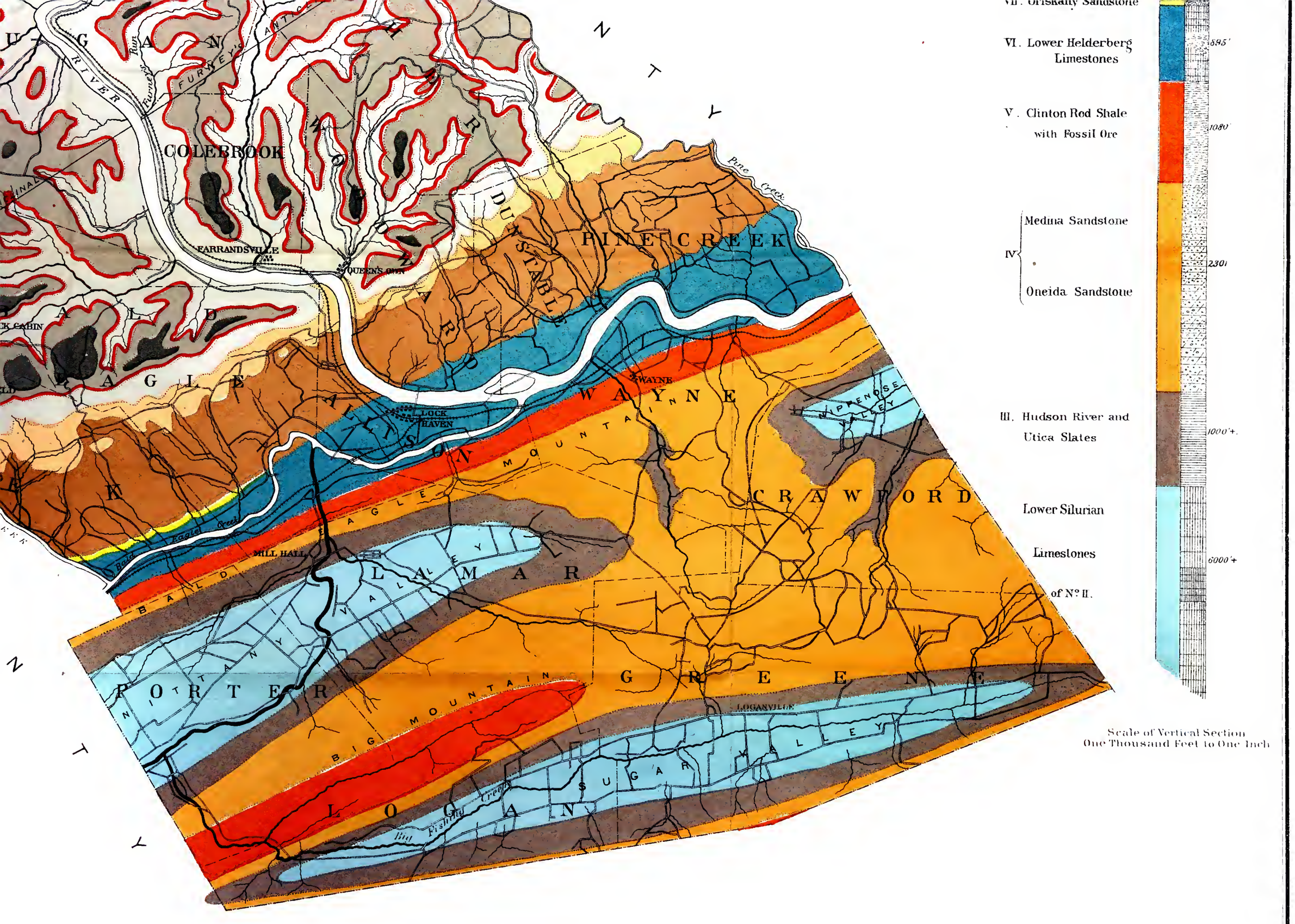
H. Martyn Chance, Asst. Geologist.

1879.

Scale: 2 miles 1 inch.

1 ¾ ½ ¼ 0 2 4 6 Miles

LANE S. HART, STATE PRINTER



VII. Oriskany Sandstone

VI. Lower Helderberg Limestones — 395'

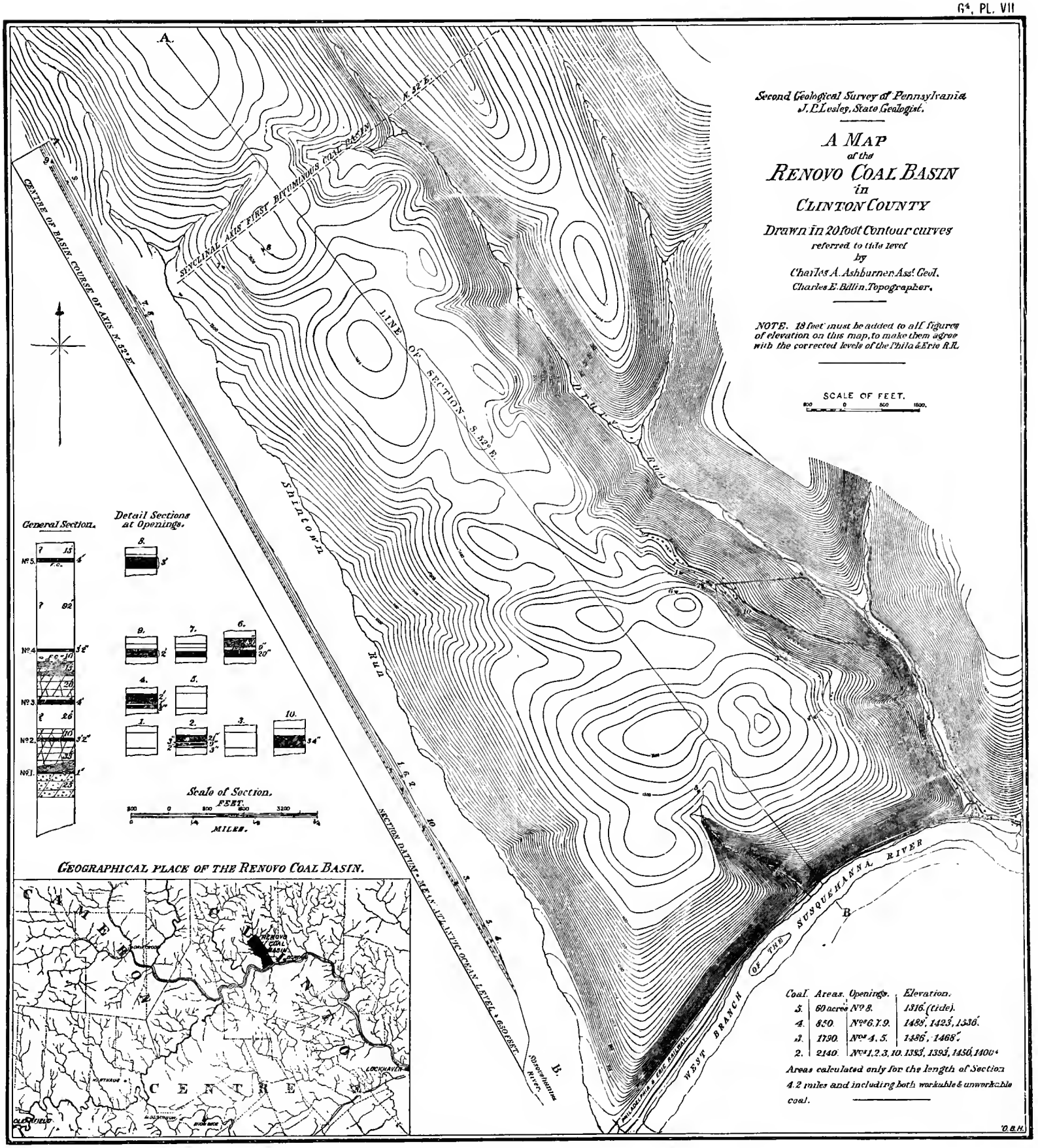
V. Clinton Rod Shale with Fossil Ore — 1080'

IV. Medina Sandstone / Oneida Sandstone — 2301

III. Hudson River and Utica Slates — 1000'+.

Lower Silurian Limestones of N° II. — 6000'+

Scale of Vertical Section
One Thousand Feet to One Inch



Coal.	Areas.	Openings.	Elevation.
5.	60 acres	No 8.	1316' (tide).
4.	850.	Nos 6. 7. 9.	1488', 1425', 1536'.
3.	1790.	Nos 4, 5.	1386', 1468'.
2.	2140.	Nos 1, 2, 3, 10.	1393', 1393', 1450', 1400'.

Areas calculated only for the length of Section 4.2 miles and including both workable & unworkable coal.

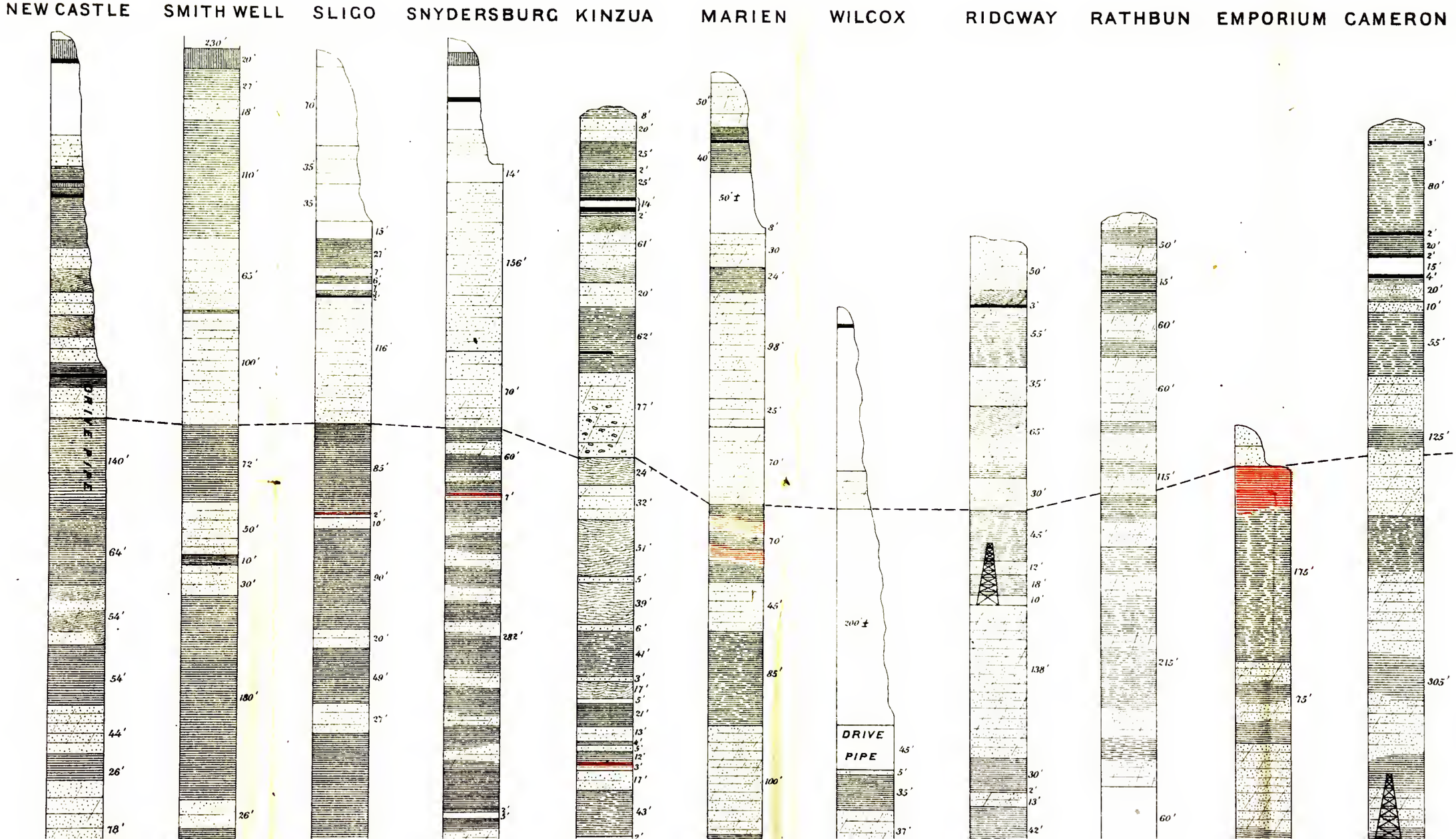
O. B. H.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

J. P. LESLEY, STATE GEOLOGIST.

SECTIONS OF THE SUB-CARBONIFEROUS ROCKS FROM THE ALL

BY H. MARTYN CHANCE, ASST. GEOLOGIST.

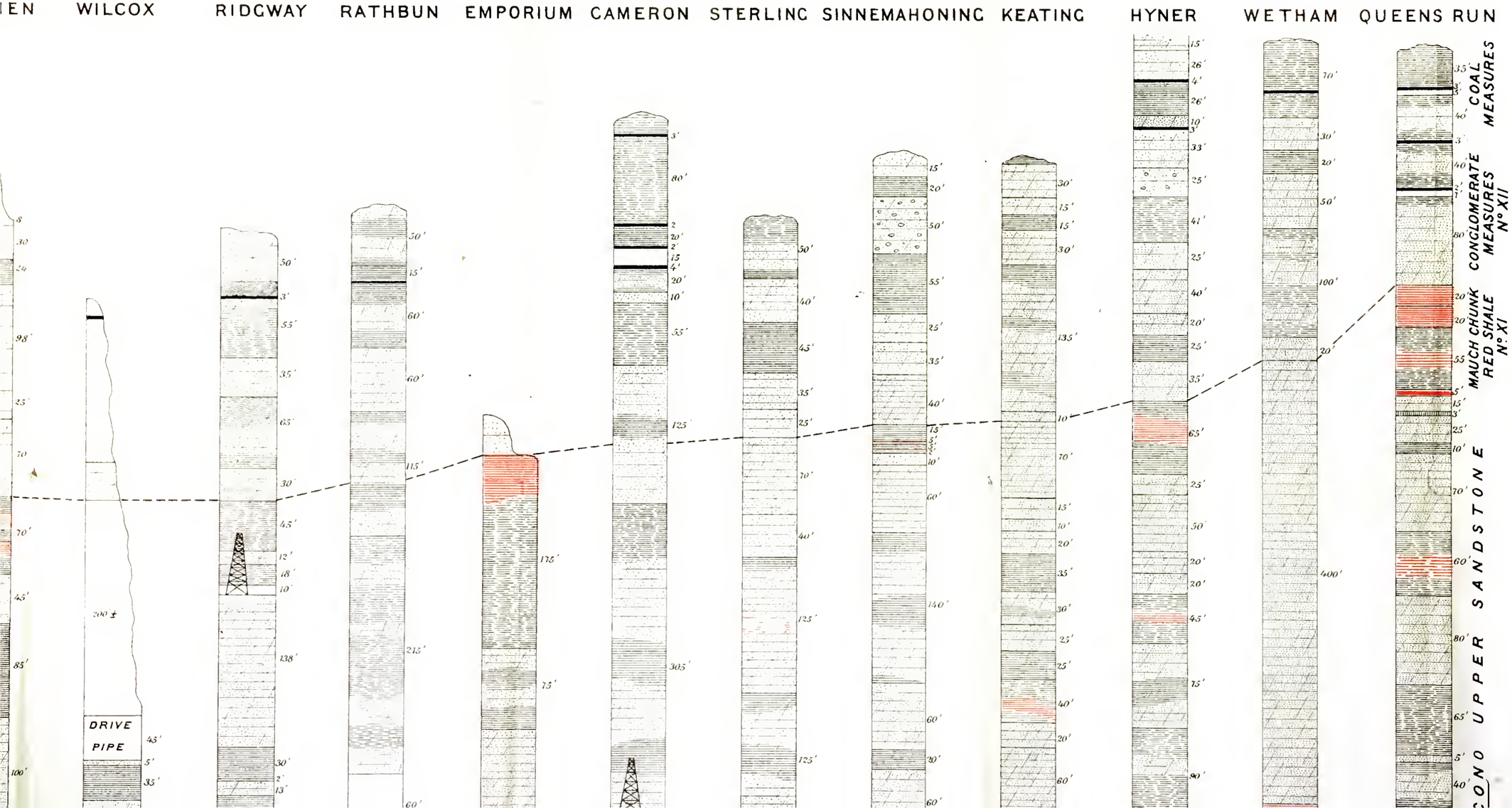


SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.

J. P. LESLEY, STATE GEOLOGIST.

RBONIFEROUS ROCKS FROM THE ALLEGHENY MOUNTAINS TO OHIO

BY H. MARTYN CHANCE, ASST. GEOLOGIST.



CHEMUNG SHALES

26′ 78′ 85′ 151′ 43′ 70′ 30′ 75′ 30′

1732′ of soft Devonian Rocks to bottom of well

OIL SAND GROUP

26′ 119′ 15′ 60′ 85′ 20′ 20′ 20′ 55′ 31′ 19′

LOWER POCONO

284′ 5′ 10′ 21′ 29′ 77′ 3′ 30′ 112′ 14′ 30′ 36′ 11′ 13′ 10′

OIL SAND GROUP

3′ 3′ 138′ 30′ 110′ 27′ 20′ 5′ 40′ 50′ 17′ 12′ 9′ 11′ 35′ 11′ 96′

3′ 17′ 43′ 2′ 9′ 14′ 3′ 62′ 15′ 3′ 9′ 18′ 27′ 26′ 18′ 11′ 10′ 34′ 8′ 15′ 1′ 8′ 6′ 6′

100′ 20′ 13′ 204′ 25′ 18′ 76′ 12′ 30′ 15′ 10′ 25′ 20′ 25′ 15′ 114′ 15′ 30′ 83′

5′ 35′ 37′ 18′ 10′ 10′ 5′ 20′ 25′ 105′ 15′ 15′ 15′ 25′ 15′ 30′ 15′ 5′ 7′ 8′ 15′ 75′ 7′ 43′ 75′ 30′ 5′ 15′ 5′ 55′ 25′ 5′ 5′ 5′ 23′ 7′ 25′ 10′

970′ of Chemung Shales to bottom of well

60′

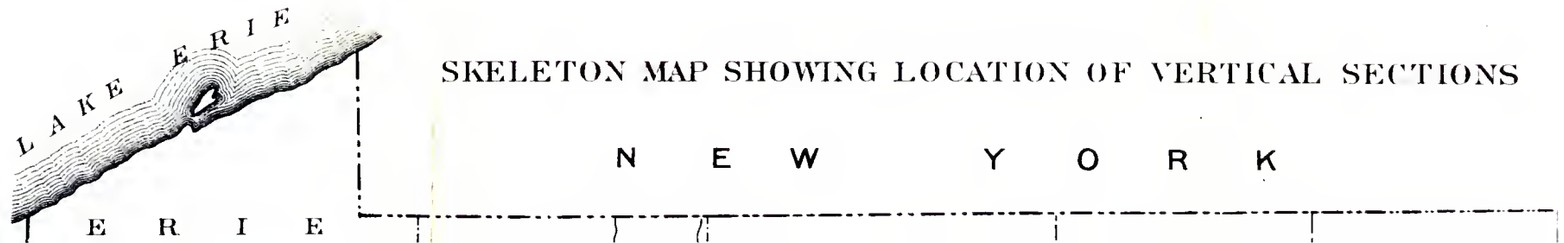
30′ 2′ 13′ 42′ 8′ 27′ 23′ 14′ 11′ 30′ 9′ 11′ 9′ 10′ 9′ 24′ 99′ 6′ 41′ 15′ 22′ 5′ 23′ 5′ 6′ 43′ 31′ 54′ 10′

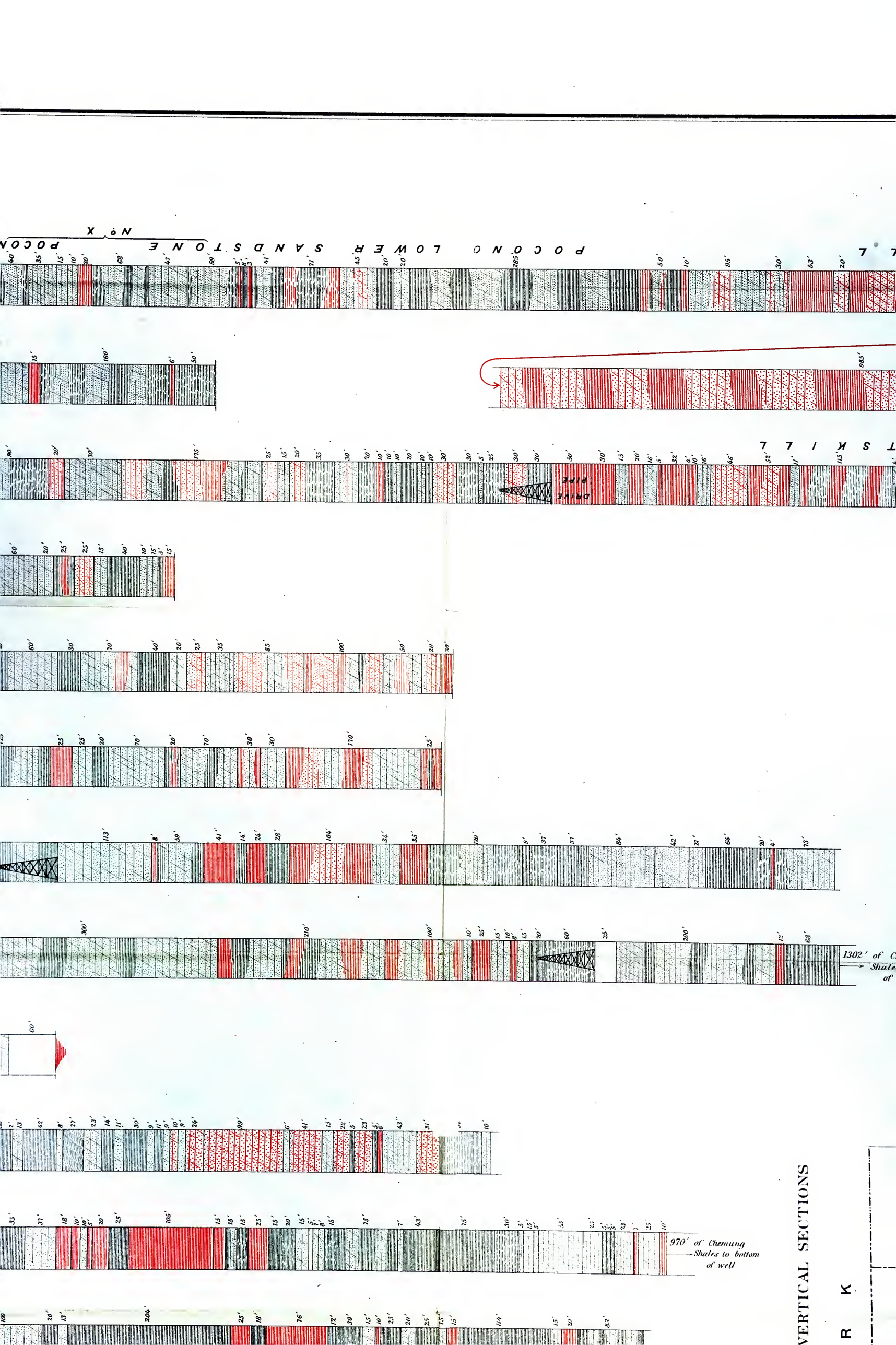
300′ 210′ 100′ 10′ 25′ 15′ 10′ 8′ 15′ 20′ 60′ 25′ 84′ 200′ 12′ 68′

1302′ of Shales

113′ 8′ 59′ 41′ 14′ 24′ 28′ 104′ 34′ 35′ 120′ 9′ 37′ 37′ 84′ 42′ 21′ 64′ 20′ 4′ 73′

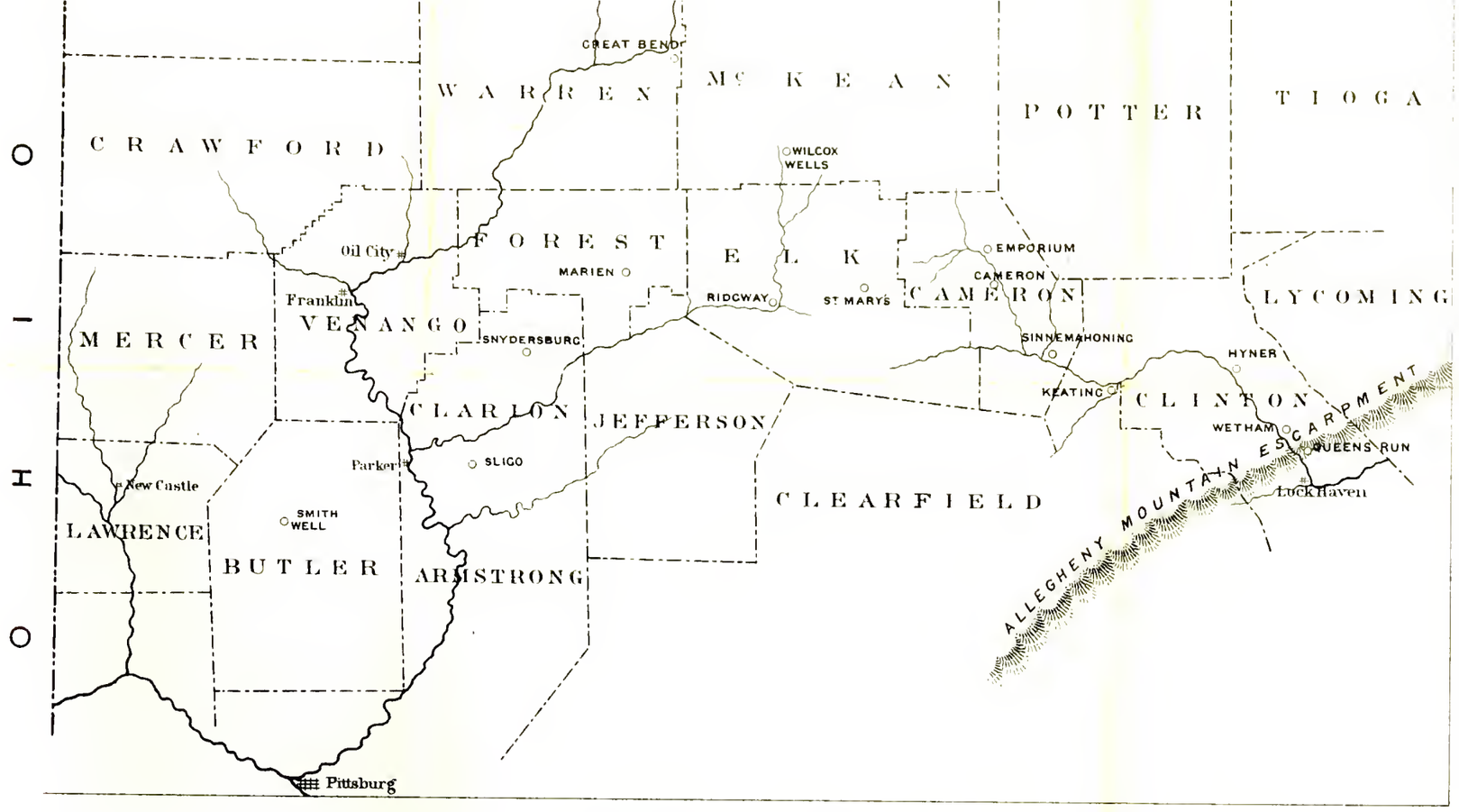
SKELETON MAP SHOWING LOCATION OF VERTICAL SECTIONS





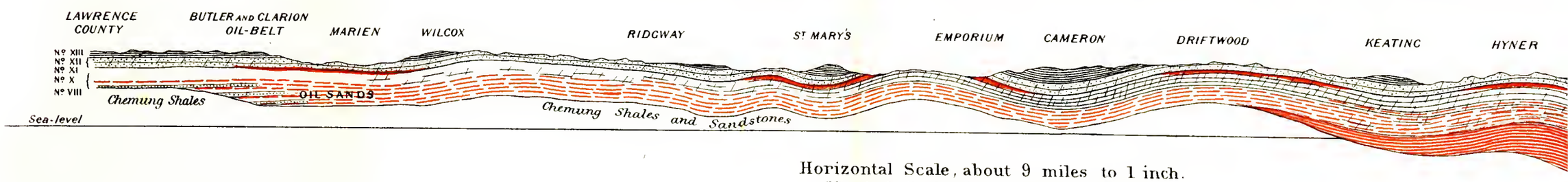
VERTICAL SECTIONS

R K



Scale of Map, 18 $\frac{3}{4}$ miles to 1 inch.
Scale of Sections, 100 feet to 1 inch.

PROFILE SECTION FROM QUEENS RUN, CLINTON COUNTY TO NEW CASTLE, LAWRENCE COUNT



Horizontal Scale, about 9 miles to 1 inch.
Vertical Scale, 3000 feet to 1 inch.
Ratio of Exaggeration 1:15.84.

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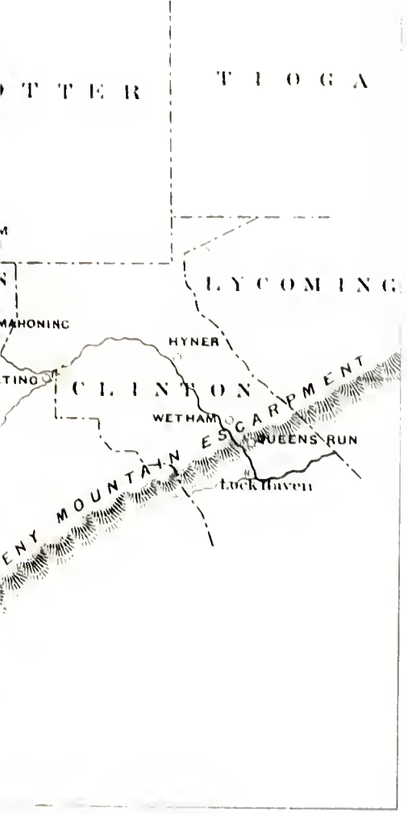
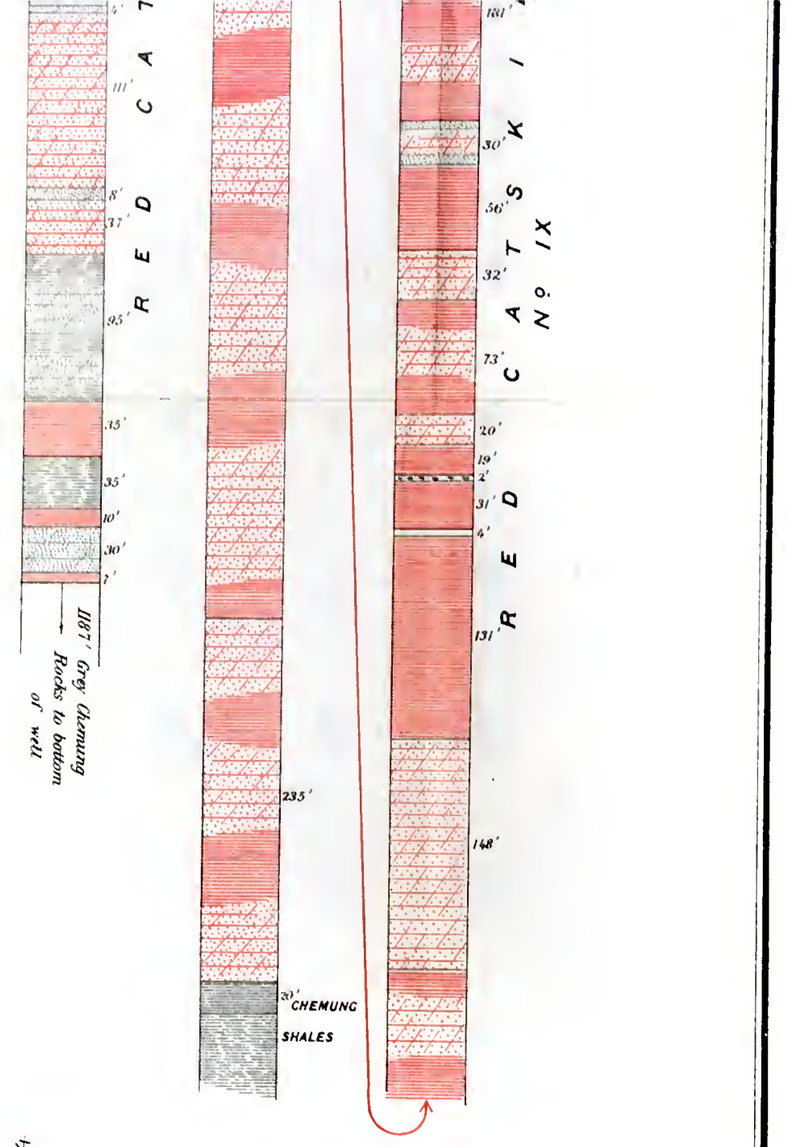
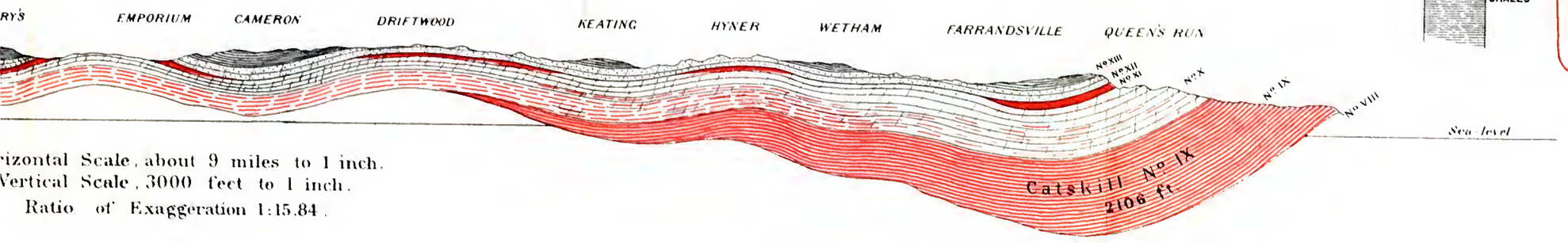




RUN, CLINTON COUNTY TO NEW CASTLE, LAWRENCE COUNTY, PA.



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Vertical Scale, 3000 feet to 1 inch.
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